

MT-95000/MT-96000

Host Control

Operations Manual



**MT-95000/MT-96000
Host Control
Operations Manual**

Astro-Med, Inc.

Part Number

22834-196

Serial Number _____

Issued to _____

© Copyright 1989

This manual is copyrighted with all rights reserved. No part of this manual may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language in any form by any means without written permission of Astro-Med, Inc. Printed in the United States of America.

Limited Warranty

Astro-Med warrants this hardware product against defects in materials or workmanship for a period of two years from the date of original purchase. If you discover a defect, Astro-Med will, at its option, repair or replace this product at no additional charge except as set forth below. Repair parts and replacement products will be furnished on an exchange basis and will be either reconditioned or new. All replaced parts become the property of Astro-Med.

The printhead warranty is invalid if the printhead is damaged by unapproved chart paper. Contact the factory for information about approved chart papers.

This warranty does not apply if the product has been damaged by accident, abuse, misuse, or misapplication; or has been modified without the written permission of Astro-Med.

To obtain warranty services, send your product, freight prepaid, to our factory at: Astro-Med Industrial Park, West Warwick, Rhode Island, 02893. Call (401) 828-4000 for further information. Astro-Med is not responsible for your product if it is lost or damaged in transit.

Astro-Med makes no warranty, either express or implied, with respect to this product's fitness for a particular purpose.

Printed in the United States of America

Recorder Identification Data

Congratulations. Your Astro-Med purchase is an investment in the finest of state-of-the-art recorder technology. The information provided below lists the model number, serial number, and software version of your chart recorder. Verify that the software configuration number (SCN) that appears on the display of your chart recorder after it has been powered-up exactly matches the software version given below. The software version recorded below is the most current software version available for your chart recorder. As noted below, the software version number represents the software as originally installed in your instrument. Any upgrades of the chart recorder's resident software should be noted in the space provided. If, for any reason, it should be necessary for you to contact Astro-Med regarding your purchase, please refer to the following:

Model Number: _____

Serial Number: _____

Software Version: _____
(original installation)

Upgraded Software Version: _____
(date installed: __/__/__)

Upgraded Software Version: _____
(date installed: __/__/__)

Upgraded Software Version: _____
(date installed: __/__/__)

Astro-Med, Inc
Astro-Med Industrial Park, West Warwick, RI 02893
1 (401) 828-4000



Digitized by the Internet Archive
in 2026

https://archive.org/details/manualsplus_11522

Table of Contents

CHAPTER 1: Introduction 1-1

MT-95000/MT-96000 Host Control	
Operations Manual	1-2
Establishing Host Control	1-2
System Setup	1-2
Modes of Operation	1-3

CHAPTER 2: Establishing Host Control 2-1

<i>Linking Via RS-232</i>	2-1
Pin Connection	2-1
Setting RS-232 Communications Attributes	2-4
Enabling and Exiting Remote Control Operation	2-5
Aborting Operation Under RS-232 Control	2-6
 <i>Linking Via GPIB</i>	2-6
Pin Connection	2-6
Setting GPIB Communications Attributes	2-7
GPIB Capabilities	2-9
Interface Commands	2-9
Serial Poll	2-10

CHAPTER 3: Host Control Operation 3-1

Section 3-1: Command Structure 3-2

Section 3-2: System Setup 3-3

Initial Preparation 3-3

Form Feed Command 3-3

Help Sheet Command 3-3

System Setup Mode 3-4

System Default Setup 3-4

Storing Multiple Setups 3-4

System Setup Commands 3-6

General System Commands 3-6

Set Time 3-7

Set Date 3-7

Motor Clock Source 3-7

Memorize and Recall Setup 3-8

Gain Source 3-8

Channel Order 3-9

Timer Mark Interval 3-9

Synchronize Grid 3-9

Right System Event Marker 3-10

Left System Event Marker 3-12

Define Service Request 3-13

System Default 3-13

Error/Status 3-13

Channel Setup Commands 3-14

Signal Coupling 3-15

Voltage Range 3-15

Zero Position 3-15

Signal Polarity 3-16

Analog Channel Calibration 3-16

Interchannel Annotation/Event Marker	3-16
Signal Conditioner Reporting	3-17
Pen Lift	3-17
Numeric Calibration	3-17
Grid Setup Commands	3-18
Print Control	3-18
Minor Divisions	3-18
Automatic Identification	3-18
Acquire Setup Commands	3-19
Sample Rate	3-19
Storage Method	3-20
Trigger Setup Commands	3-20
Trigger Source	3-20
Trigger Level/Slope	3-21
Trigger Position	3-21
Playback Setup Commands	3-22
X and Y Channels	3-22
Magnification	3-22
Playback Percentage	3-23
Exit Setup Mode Command	3-23
Section 3-3: Real-time Recording Modes	3-24
<i>Analog Real-time Recorder Mode</i>	<i>3-24</i>
<i>Analog Real-time Recorder Commands</i>	<i>3-25</i>
Start/Stop Toggle	3-26
Run and Halt	3-26
Set/Change Motor Speed	3-27
Identification	3-27
System Log Channel	3-27
Edit System Log Channel	3-27
Interchannel Text Buffer	3-27
Edit Interchannel Text Buffer	3-28

Timer Mark Interval	3-28
System Event Marker	3-28
Right System Event Marker	3-29
Left System Event Marker	3-30
Background Data Capture	3-31
Error/Status	3-32
Exit Analog Real-time Recorder Mode	3-32
<i>Data Logger Mode</i>	3-33
<i>Data Logger Commands</i>	3-33
Start/Stop Toggle	3-33
Run and Halt	3-35
Set/Change Logging Speed	3-35
Background Data Capture	3-35
Error/Status	3-36
Exit Data Logger Mode	3-36
 Section 3-4: Data Capture and Playback Modes	3-37
 <i>Data Capture Mode</i>	3-37
<i>Data Capture Commands</i>	3-37
Error/Status	3-38
Exit	3-38
 <i>Data Playback Mode</i>	3-38
<i>Data Playback Commands</i>	3-39
Start/Stop Toggle	3-39
Run and Halt	3-40
Identification	3-40
Interchannel Text Buffer	3-40
Edit Interchannel Text Buffer	3-40
Error/Status	3-41
Exit Data Playback Mode	3-41

Section 3-5: Data Transfer Modes	3-42
---	-------------

<i>Digital Data Recorder Mode</i>	3-42
Data Packets	3-43
Control Packets	3-45
<i>Digital Data Recorder Commands</i>	3-46
Identification	3-46
System Log Channel	3-46
Edit System Log Channel	3-46
Interchannel Text Buffer	3-47
Edit Interchannel Text Buffer	3-47
System Event Marker	3-47
Pen Lift	3-48
Signal Polarity	3-48
Motor Step	3-48
Exit Digital Data Recorder Mode	3-48
<i>Data Transfer (Upload)</i>	3-49
<i>Data Transfer Commands</i>	3-49
Request Information	3-50
Waveform Transfer	3-50
Exit Data Transfer Mode	3-51

Section 3-6: Printing Modes	3-52
------------------------------------	-------------

<i>Line Printer Modes</i>	3-52
<i>Rotated Printer Modes</i>	3-53
ASCII Character Data	3-53
Control Characters	3-57
<i>Plotter Mode</i>	3-57
Data Packets	3-58
Control Packets	3-60

<i>Plotter Commands</i>	3-60
Change Print Resolution	3-60
Exit Plotter Mode	3-60

<i>Appendix A: Command Headers</i>	A-1
---	-----

<i>Appendix B: Event Marker Options</i>	B-1
--	-----

<i>Appendix C: Multiline Interface Messages</i>	C-1
--	-----

<i>Index</i>	I-1
---------------------	-----

List of Tables

Chapter 2

Table 2-1	DTR/DSR Handshaking	2-3
Table 2-2	Xon/Xoff Handshaking	2-3
Table 2-3	GPIO (IEEE-488) Pin Connection Data	2-6

Chapter 3

Table 3-1	MT-95000/MT-96000 Mode Commands	3-2
Table 3-2	Default Operating Conditions	3-5
Table 3-3	General System Commands	3-6
Table 3-4	Vertical Grid Synchronization	3-10
Table 3-5	Tri-level Event Markers	3-11
Table 3-6	Channel Setup Commands	3-14
Table 3-7	Grid Setup Commands	3-18
Table 3-8	Acquire Setup Commands	3-19
Table 3-9	Trigger Setup Commands	3-20
Table 3-10	Playback Setup Commands	3-22
Table 3-11	Exit Setup Mode Command	3-23
Table 3-12	Analog Real-time Recorder Commands	3-25
Table 3-13	Tri-level Event Markers	3-30
Table 3-14	Data Logger Commands	3-34
Table 3-15	Acquire (Data Capture) Commands	3-37
Table 3-16	Data Playback Mode Commands	3-39
Table 3-17	Digital Data Recorder Mode Commands	3-46
Table 3-18	Data Transfer Mode Commands	3-49
Table 3-19	Plotter Mode Commands	3-60

List of Illustrations

Chapter 2

Figure 2-1	MT-95000 Rear Panel and CPU Board End Plate	2-2
------------	--	-----

Chapter 3

Figure 3-1	80-Column Line Printer	3-54
Figure 3-2	80-Column Line Printer (180° rotation)	3-55
Figure 3-3	Rotated Printer Mode	3-56

Chapter 1 Introduction

Astro-Med's MT-95000 and MT-96000 Recorders come with a documentation package that can help you to exploit the full potential of the recorder. If you plan to operate the recorder under the control of a host computer, you would derive most benefit by becoming familiar with all three manuals:

The *MT-95000/MT-96000 Host Control Operations Manual* provides information on the operation of the MT-95000 and MT-96000 Recorders under the control of a host computer. You will use this manual as your primary source of information on the recorder's operating modes and associated commands.

The *MT-95000/MT-96000 Operations Manual* provides information on the operation of the MT-95000 and MT-96000 Recorders as stand-alone instruments and contains much valuable information about the recorders and their modes of operation. Whenever additional information is desired about a mode of operation, a recorder option, any theory of operation, or recorder feature, refer to this manual.

The *MT-95000/MT-96000 Maintenance and Service Manual* provides information on troubleshooting and routine recorder maintenance.

MT-95000/MT-96000 Host Control Operations Manual

This manual is organized to present information in the following order:

- First, in Chapter 2, the information required to establish the link between the host computer and the MT-95000/MT-96000 Recorder is provided.
- System setup information is presented next, in Chapter 3, to enable you to specify the conditions and results of the recorder's output.
- Finally, the modes of operation and their associated commands are fully described.

Establishing Host Control

Host control of the MT-95000 and MT-96000 Recorders can be established through either an RS-232 serial port or a GPIB (IEEE-488) port. In addition to controlling operation of the recorder, the host computer can receive data from and transfer data to the recorder over the communications interface.

The MT-95000/MT-96000 can record signals that are transferred from the host. The download can occur while the recorder is in Digital Data Recorder Mode, as described in Section 3-5 of this manual. This mode is the only one of the recorder modes that requires a GPIB (IEEE-488) link.

Requirements for both interfaces are explained in Chapter 2 of this manual.

System Setup

The MT-95000 and MT-96000 Recorders can be operated immediately after establishing control under the current or active system setup. The recorders also have a factory-set default setup available. However, before beginning to use the recorder, you will probably want to customize the output to your own requirements and preferences. You can alter any of the system parameters to create another current (active) system setup, as well as store three additional setups for immediate recall.

Modes of Operation

Host control of the MT-95000/MT-96000 permits use of the same modes as are available during standalone operation. In addition, there are several modes that are unique to host-control operation.

Through host control, the recorder is able to:

- Record real-time analog chart representations or digital data
- Capture and store data to be played back (printed) at a later time
- Receive data from or transmit data to the host computer
- Function as a line printer or plotter

The host computer transmits simple mnemonic-based commands to the recorder to access and exit the various operational modes. The recorder while not performing any operation is in Idle Mode and awaiting instruction.

In general, the recorder modes have a tree structure. You enter a particular branch or mode from Idle Mode, and must return to Idle Mode before moving to another branch. The modes of operation can be represented as follows:

Idle	Mode
	Help Sheet
System Setup	Data Logger
Analog Real-time	Data Playback
Data Capture	Data Transfer
Digital Data	Rotated Printer
Line Printer	Plotter
Form Feed	
Idle	Mode

Each mode has a particular set of commands available to it, although some commands are available to several modes.

Some modes of operation require specific options to be installed in the recorder. Wherever this is the case, it is noted at the beginning of the section describing the mode.

All modes and their related commands are described in Chapter 3, "Host Control Operation."

Chapter 2 Establishing Host Control

The MT-95000 and MT-96000 Recorders can be linked to a host computer via either an RS-232 or GPIB interface. The RS-232 and GPIB D-shell interfaces are located on the end plate of the CPU Board on the MT-95000/MT-96000 rear panel. This end plate is the third one to the right of the recorders' identification and power requirement stickers. Figure 2-1 illustrates the rear panel, with an enlarged view of the CPU Board end plate.

The first step in setting up host control is to ensure proper cable connection and set the transmission protocol. Communications attributes include different baud rates and handshaking protocols. These parameters are set on the recorder itself through the SYSTEM menu.

Linking Via RS-232

Pin Connection

The RS-232 25-pin D-shell connector is the RS-232 communications interface between the MT-95000 and MT-96000 Recorders and various host-computer configurations. Pin connection data for the RS-232 connector is provided in Tables 2-1 and 2-2. It is important to design the proper interconnection depending upon the handshaking method chosen and the host interface.

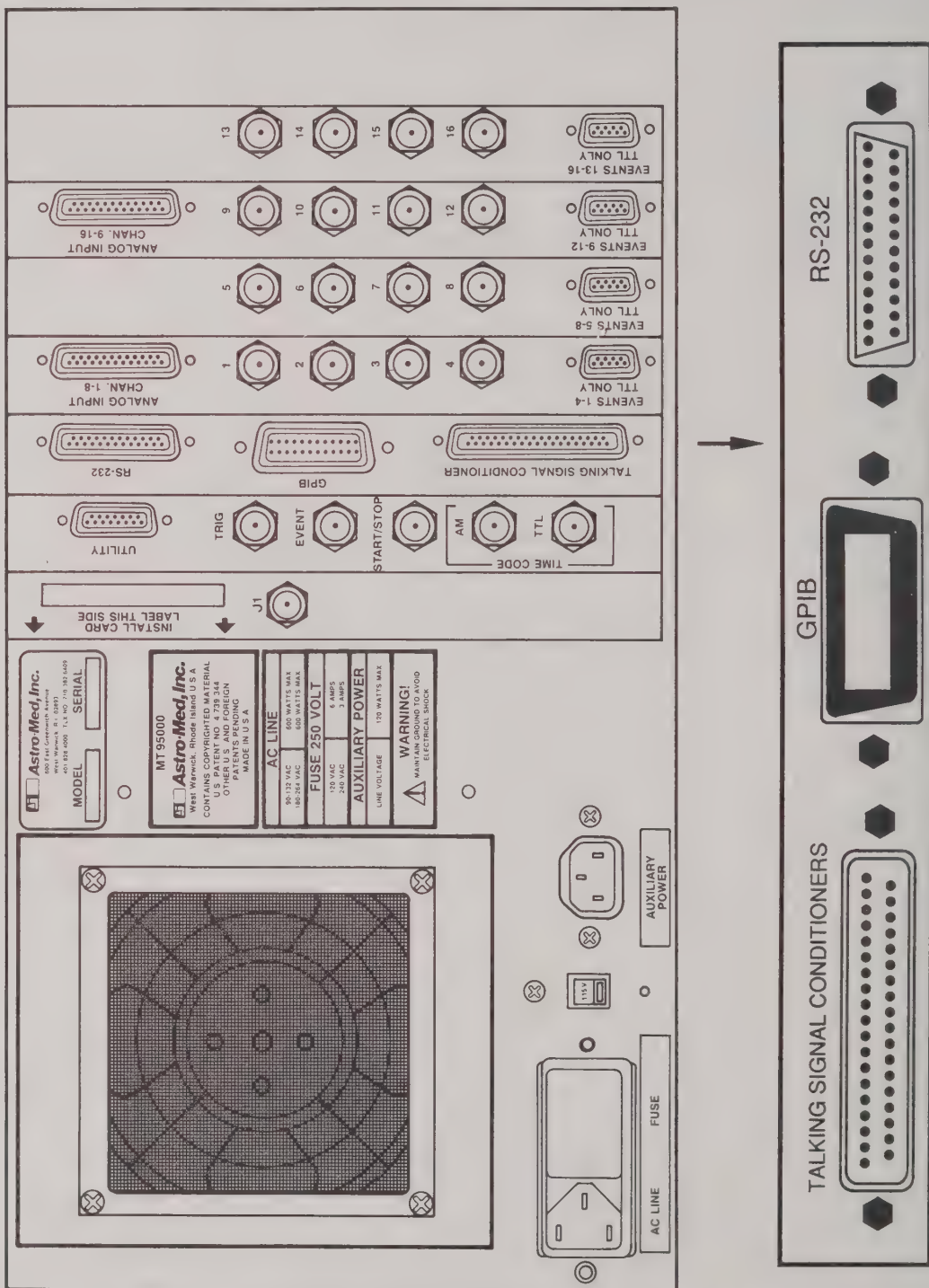


Figure 2-1: MT-95000 Rear Panel and CPU Board End Plate

Table 2-1: DTR/DSR Handshaking

<i>Pin #</i>	<i>Description</i>	<i>Source</i>
2	RXD	host
3	TXD	MT-95000/MT-96000
4	CTS	*
5	RTS	*
6	DTR	MT-95000/MT-96000
7	COMMON	-
20	DSR	host

* Pins 4 and 5 are connected internally in the MT-95000/MT-96000.

All other pins are reserved and should not be used. The MT-95000/MT-96000 uses DTR/DSR handshaking in both listening and talking modes.

Table 2-2: Xon/Xoff Handshaking

<i>Pin #</i>	<i>Description</i>	<i>Host</i>
2	RXD	TXD
3	TXD	RXD
7	COMMON	COMMON
18	RS-232 +V	} tied
20	DSR	

With Xon/Xoff handshaking, transmission of control characters enables or disables data transmission. ASCII character DC1 (Xon) enables transmission; ASCII character DC3 (Xoff) disables transmission.

The recorder accepts data into an internal buffer of 256 bytes. When the buffer is 75% full (192 bytes), the recorder sends Xoff to the host. When the buffer is reduced to 25% full (64 bytes), the recorder sends Xon to the host.

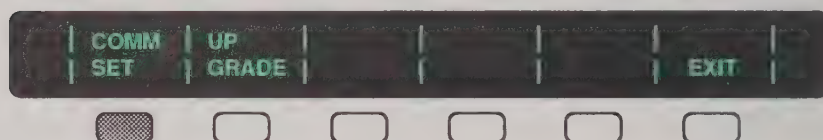
Setting RS-232 Communications Attributes

Data transmission specifications for RS-232 are as follows:

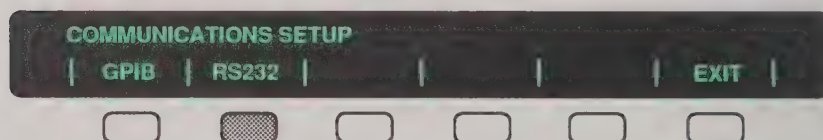
Baud rate:	300, 1200, 2400, 4800, 9600, and 19,200
Parity:	none
Data bits:	8
Stop bits:	2
Handshake:	hardware or Xon/Xoff

To select the baud rate and handshake protocol, press the **SYS-TEM** key on the recorder. Level 1 of the system menu displays. Press the soft key beneath “more” to invoke Level 2 of the system menu, then press the soft key beneath “more” once again to invoke Level 3 of the system menu.

Press the soft key beneath **I/O** to invoke the communications menu; then press the soft key beneath **COMM SET**.



The following menu allows you to define the communications setup for host control operation.



Press the soft key beneath **RS232** to specify RS-232 communications and access the menu that allows you to set the attributes.



You set the baud rate and handshake method from this menu.

Use the NEXT or PREV keys to scroll either forward or backward through six available baud rates: 300, 1200, 2400, 4800, 9600, or 19,200.

Use the H/W or XON keys to specify whether communications control will be hardwired via cable (DTR/DSR) or implemented via software instruction (Xon/Xoff).

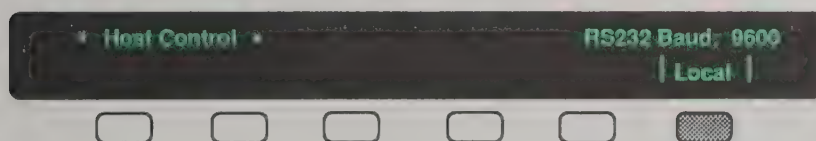
Both current selections are indicated on the display. This information is stored in non-volatile memory, allowing the device to power up in these conditions from that point on. Press the soft key beneath EXIT to return the recorder to the COMMUNICATIONS SETUP display.

Enabling and Exiting Remote Control Operation

RS-232 communication can be enabled or disabled by sending a command from the host computer to the MT-95000/MT-96000 when the recorder is in Idle Mode (ready). The host sends the following commands:

RC<cr><lf>	to enable remote control
EH<cr><lf>	to exit host (remote) control

After remote control via RS-232 has been established, you need only to follow the command structure presented in Chapter 3, "Host Control Operation." While in this state, the recorder displays:



You can also exit host control by using the front panel soft key under Local on the display.

Command strings from the host via RS-232 are to be terminated by a line feed <lf>. A carriage return <cr> may also be included. In this manual the terminator is indicated as <cr><lf>. The recorder will also send RS-232 responses with a <cr><lf> terminator.

Aborting Operation Under RS-232 Control

The Abort Command can be sent over the RS-232 communication link while under local or host control. This command CTRL-X (18H) causes the MT-95000/MT-96000 to go to Idle Mode. All input and output buffers are cleared.

If the recorder is under local control, you can send a Remote Control Command (RC) to gain host control; if the recorder was under host control, it will remain under RS-232 host control.

Linking Via GPIB

Pin Connection

The GPIB D-shell connector is the IEEE communications interface between the MT-95000 and MT-96000 Recorders and various host-computer configurations. The GPIB connection on the MT-95000 and MT-96000 Recorders is located on the CPU Board end plate on the recorder's rear panel, as illustrated in Figure 2-1. Pin connection data for the GPIB (IEEE-488) connector is provided in Table 2-3:

Table 2-3: GPIB (IEEE-488) Pin Connection Data

<i>Pin #</i>	<i>Description</i>	<i>Pin #</i>	<i>Description</i>
1	DI01	13	DI05
2	DI02	14	DI06
3	DI03	15	DI07
4	DI04	16	DI08
5	EOI	17	REN
6	DAV	18	GROUND (6)
7	NRFD	19	GROUND (7)
8	NDAC	20	GROUND (8)
9	IFC	21	GROUND (9)
10	SRQ	22	GROUND (10)
11	ATN	23	GROUND (11)
12	SHIELD	24	GROUND LOGIC

GROUND (X) = the signal ground return of the referenced contact

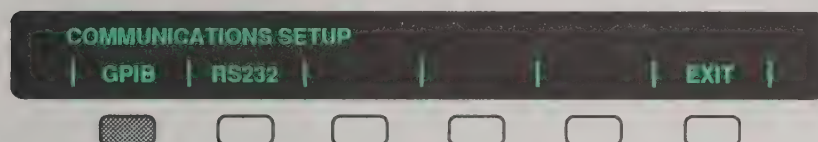
Setting GPIB Communications Attributes

To set the attributes for GPIB communication, press the SYSTEM key on the recorder. Level 1 of the system menu displays. Press the soft key beneath “more” to invoke Level 2 of the system menu, then press the soft key beneath “more” once again to invoke Level 3 of the system menu.

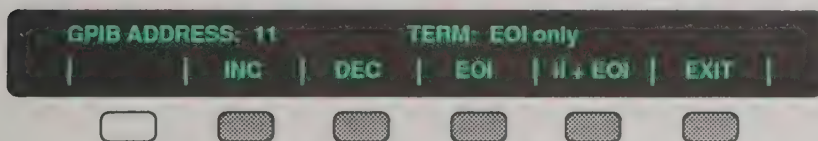
Press the soft key beneath I/O to invoke the communications menu. Then press the soft key beneath COMM SET to access the menu that allows you to define the communications setup for host control operation:



After pressing the soft key beneath COMM SET on the communications menu, the following menu displays:



From this menu, press the soft key beneath GPIB. From the GPIB menu, you specify a GPIB address and a terminator for all command sequences.

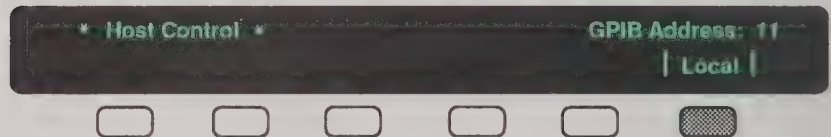


Press the soft key beneath INC to increase the GPIB address to the next higher address number. Press the soft key beneath DEC to decrease the GPIB address to the next lower address number. Valid addresses for any device are 00-30 inclusive. This address is stored in non-volatile memory and will not be affected by power loss.

Press the soft key beneath EOI (end or identify) to specify that only an EOI pulse will be recognized as a terminator. Press the soft key beneath lf+EOI to specify that a line feed <lf> control character plus an EOI pulse will be recognized as a terminator. If EOI only is selected, it is required that EOI = 1 be sent on the last byte of the data transfer or command sequence. In this manual the GPIB terminator is indicated as (EOI = 1 on last byte).

Both current selections are indicated on the display. Press the soft key beneath EXIT to return the recorder to the COMMUNICATIONS SETUP display.

After remote control via GPIB has been established, you need only to follow the command structure presented in Chapter 3, "Host Control Operation." While in this state, the recorder displays:



To return to local control, simply press the soft key beneath Local on the display.

Return to local control can also be disabled, as described on page 2-9. When local control is disabled, the display reads:



GPIB Capabilities

GPIB communication between the host computer and the MT-95000/MT-96000 Recorder provides the following functions:

Source handshake	(SH1)	complete capability
Acceptor handshake	(AH1)	complete capability
Talker	(T6)	basic talker with serial poll
Extended talker	(TE0)	no capability
Listener	(L4)	basic listener
Service request	(SR1)	complete capability
Remote/local	(RL1)	complete capability
Device trigger	(DT1)	complete capability
Device clear	(DC1)	complete capability
Parallel poll	(PP0)	no capability
Bus drivers	(E2)	tri-state drivers

Separator for input: EOI or <lf>/EOI

Separator for output:EOI or <lf>/EOI

Interface Commands

The following commands are sent from the host to the recorder(s) for the purposes described. With the ATN (attention) line true, multiline messages are interpreted as interface messages. See Appendix C for codes.

GTL (Go to Local)	Allows local operation of the recorder
GET (Group Execute Trigger)	Causes a valid trigger
DCL (Device Clear)	Clears the input and output buffers and places the unit at Idle Mode command level
SDC (Selected Device Clear)	Causes an addressed MT-95000/MT-96000 to clear input and output buffers and place the unit at Idle Mode command level
LLO (Local Lockout)	Locks out the operator from returning to local control from the front panel
SPE (Serial Poll Enable)	Notifies all devices on the GPIB that the controller has placed the GPIB in the serial poll mode

SPD (Serial Poll Disable)	Notifies all devices on the GPIB that the controller has completed the serial poll
MLA (My Listen Address)	Message/address to devices whose address is specified to enable listener status
MTA (My Talk Address)	Message/address to devices whose address is specified to enable talker status
UNL (Unlisten)	Message to device(s) to enter unlisten state
UNT (Untalk)	Message to device(s) to enter untalk state

Serial Poll

In certain applications it may be necessary for the host to know the state of the MT-95000/MT-96000 Recorder. This may include troubleshooting command errors or completion of an operation. By use of service requests (SRQ), the recorder informs the host of its status.

Upon receiving an SRQ, the controller in charge performs a serial poll in search of the device(s) that has requested service; the device that has been enabled and addressed responds with a status byte (STB) message.

The status byte returned by the recorder contains information as to whether that recorder requested service ($rsv = 1$) and, if so, the reason:

Status Byte Message:	7	6	5	4	3	2	1	0
	0	rsv	0	0	0	0	DE	I

I (bit 0) indicates interlock situation (paper out/door open).
 DE (bit 1) indicates a command or data error.

In the case of an interlock situation ($bit\ 0 = 1$), the recorder will not accept data until the condition is corrected. A command error ($bit\ 1 = 1$) usually occurs because improper code sequences were sent to the recorder.

Chapter 3 Host Control Operation

The MT-95000 and MT-96000 Recorders respond to a simple mnemonic-based set of commands that allows easy access to and exit from a variety of operational modes. The recorder while not performing any operation is in Idle Mode and awaiting instruction.

To instruct the recorder to enter or exit a mode or to perform a function, you send it a command from the host. A command is comprised of a header and parameters and is concluded by a message terminator.

COMMAND FORMAT: [XX] [n],[x] [*]
 | └───┬───┘
 | parameters
 | terminator
 |
 header

Command Header: a two-character device command for any function. The command header may be either upper or lower case characters. They are depicted as upper case throughout this manual.

Command Header Separator: a space. A minimum of one space is required between the header and parameters.

Parameters: program data that completes the command string

Parameter separator: a comma between parameters; a space after last parameter

Command terminator: typically a newline character, but depends on type of communication and terminator selected

In general, the MT-95000 and MT-96000 have two levels of commands: mode commands and function commands. The mode commands enter the recorder into a particular mode of operation; the function commands are executed within the modes to perform functions.

Many of the function commands are common to a variety of modes. In Section 3-2 the commands that are available in System Setup Mode are described. The commands that are available to a particular mode are described in Sections 3-3 through 3-6.

At power up, the recorder is in Idle Mode. You enter any of the following modes from Idle Mode and exit to Idle Mode when done.

Table 3-1: MT-95000/MT-96000 Mode Commands

System Setup Mode:	SY	System Setup
Real-time Recording Modes:	RT	Analog Real-time Recorder
	DL	Data Logger
Data Capture and Playback Modes:	AC	Acquire (Data Capture)
	PB	Data Playback
Data Transfer Modes:	DS	Digital Data Recorder
	XF	Data Transfer
Additional Printing Modes:	LP	Line Printer
	RP	Rotated Printer
	HR	Plotter
	FF	Form Feed
	HS	Help Sheet

Initial Preparation

Before beginning operation in any of the MT-95000's or MT-96000's modes, you need to decide on the system parameters that will control operation. As a first step, you may want to set the recorder's internal time and date. At this point you can choose to rely upon the current system settings or to change any or all of these settings. You enter the System Setup Mode to change current system parameters, as well as to save up to three different setups.

As you begin, you can use the Form Feed Command to correctly position the chart paper and the Help Sheet Command to print out basic information in condensed form.

 Form Feed

The *Form Feed Command* will cause the recorder to perform a form feed of the chart paper to the next top-of-form index mark and return to Idle Mode to await the next mode command.

Command: [FF] [*]
Parameters: none
Example: FF <cr><lf>

 Help Sheet

The *Help Sheet Command* causes the recorder to output a printed status or help sheet describing the desired information.

Command: [HS] [n] [*]
Parameters: n = 1 for general help information
 n = 2 for keystroke information
 n = 3 for MT-95000/MT-96000 status report
Example: HS 1 <cr><lf>
 prints out general help information.

System Setup Mode

Before operating the recorder in any of its modes, the system parameters should be defined. These permit you to determine at the outset how you want your chart and data printing to occur. Some of these parameters can be changed from within operating modes, but for the most part you will probably want to rely upon the convenience and ease of the system settings.

Remember, you can operate the recorder immediately after establishing control under the current settings. However, in order to customize the output to your own requirements and preferences, you may want to establish your own system setup(s) before beginning to use the recorder.



Enter System Setup Mode

To enter System Setup Mode, send the following command from the host computer to the MT-95000 or MT-96000 Recorder:

Command: [SY] [*]
Parameters: none
Example: SY <cr><lf>

Once in System Setup Mode you can use the current system setup, define or alter the current setup, use an alternate stored setup, or define or alter a stored setup. You also have the option of using a factory default setup.

System Default Setup

There is a factory default setup available and a Default Command (DF) that can be used within the System Setup Mode to establish the default settings. These settings are listed in Table 3-2.

Storing Multiple Setups

In addition to the current (active) system setup, you can store three setups for immediate recall. In the event of a loss of power, these setups are all still available. A system setup is stored when the host issues a *Memorize Setup Command* and can be recalled by issuing a *Recall Setup Command*. These commands are described in the following section.

Table 3-2: Default Operating Conditions

<i>Parameter</i>	<i>Default Condition</i>
Motor clock source	Internal
Timer	Off
Gain track	Independent
Channel order	1 through n
Service request mask	00 (no service request mask)
Coupling	Signal in
Volts	40.0 volts
Zero position	Center
Signal polarity	All signals normal
Annotation	Channel labels
Interchannel alpha- numerics/event marker	Alphanumerics
Pen lift	All signals down (printing)
Grid	On and with minor divisions
Data capture sample rate	200 kHz
Storage method/size	4 x 128K, 4K
Trigger source	manual
Slope	Rise
Level	50%
Trigger/window relationship	Start trace
X/Y channels	1 and 2
Playback expansion	Times 1
Playback percentage	Full playback (0 to 100%)
Automatic identification	Off

System Setup Commands

The commands that are available in System Setup Mode are described in the following groups:

- General System Commands
- Channel Setup
- Grid Setup
- Acquire Setup
- Trigger Setup
- Playback Setup
- Exit

Table 3-3: General System Commands

<i>Header</i>	<i>Function</i>
TI	Set time
DA	Set date
MC	Define source of motor clock
ME	Memorize (store) setup
RE	Recall (retrieve) setup
GT	Select source of gain setting
CO	Determine channel order
TT	Set timer marker interval
SG	Synchronize vertical grid (MT-96000 only)
RM	Control right system event marker
LM	Control left system event marker (MT-96000 only)
MB	Define service request mask byte (GPIB only)
DE	Set system defaults
ER	Report on MT-95000/MT-96000 status

The *General System Commands* allow you to set up conditions that generally apply to the overall system.

Set Time

The *Set Time Command* sets the time on the recorder if the recorder is set up for internal clock timing. If it is set up for external time code, this command will be ignored.

The time is transmitted as a string.

Command: [TI] [x] [*]
Parameters: x = hours, minutes, and seconds
Example: TI "12:24:35" <cr><lf>

You can also request the time from the recorder by sending the command as a query. The response time may vary depending on whether the recorder is decoding an external time code.

Request time: TI? <cr><lf>
Sample Response: TIME: 12:24:45 <cr><lf>

Set Date

The *Set Date Command* sets the date on the recorder if the recorder is set up for internal clock timing. If the recorder is set up for external time code, this command will be ignored.

The date is transmitted as a string.

Command: [DA] [x] [*]
Parameters: x = string for date
Example: DA "12/30/89" <cr><lf>

You can also request the date from the recorder by sending the command as a query. The response will be sent in a similar format. If an external time code is active, the response to a data query will be EXT xxx, where xxx is the Julian date.

Request time: DA? <cr><lf>
Sample Response: 12/30/89 <cr><lf>

Motor Clock

The *Motor Clock Source Command* defines the source of the motor clock.

Command: [MC] [x] [*]
Parameters: x = 1 for internal clock source
 x = 2 for external clock source

Example: MC 1 <cr><lf>
specifies that the recorder's internal clock will govern the motor clock.

 *Memorize/
Recall*

The *Memorize or Recall Setup Commands* allow for immediate storage of all current settings in the MT-95000 or MT-96000 Recorder. Upon power loss, these setups are still available for recall. In total, there are a maximum of four system setups available to the recorder: one current (active) and three stored.

Command: [ME] [x] [*] to memorize
[RE] [x] [*] to recall

Parameters: x = 1, 2, or 3

Example: ME 2 <cr><lf>
memorizes all current settings and stores (saves) them as recall setup 2.
RE 2 <cr><lf>
recalls and makes active all system settings stored as setup 2.

 Gain Source

The *Gain Source Command* allows you to specify the source of the gain setting. The gain may be set in three different ways:

- Independent zero and gain control for each channel as specified by the user
- The same zero and gain control for all channels, as specified for channel 1 by the user
- Zero and gain control from an external signal conditioner (requires connection of the MT-95000/MT-96000 to the C950 card cage)

Command: [GT] [x] [*]

Parameters: x = 1 for independent gain control for each channel
x = 2 for gain control of all channels as determined for channel 1
x = 3 for gain control by external signal conditioner

Example: GT 1 <cr><lf>
specifies independent gain control for each channel.



Channel Order

The *Channel Order Command* defines where each signal is placed on the chart during analog recorder and data logger modes. You enter in order the number for each analog signal. The signals will be presented from left to right in that order. You may want to order the signals for easy comparison of the waveforms.

Command: [CO] [n] [channels] [*]

Parameters: n = number of channels on chart (1 to 16)
channels = signals numbered in order of chart presentation

Example: CO 8,8,7,6,5,4,3,2,1 <cr><lf>
reverses the order of the channels.



Timer Mark

The *Timer Mark Interval Command* sets the time interval for the printing of timing marks along the right edge of the chart paper.

Command: [TT] [x] [*]

Parameters: x = 0 for .1 seconds
x = 1 for 1 second
x = 2 for 10 seconds
x = 3 for 60 seconds
x = 4 for off

Example: TT 1 <cr><lf>
causes printing of a timing mark every second.



Synchronize Grid (MT-96000 only)

For the MT-96000 Recorder only, the *Synchronize Grid Command* allows you to specify fast, medium, or slow synchronization of the vertical grid lines, or to turn off synchronization. This feature provides true time lines that do not vary with the speed of the chart output. You use this command simply to specify whether synchronization will occur and whether it will be fast, medium, or slow. Where on the chart the vertical grid lines actually print is further governed by the internal time interval selected (via DIP switch 4 or the Timer Mark Interval Command) or by the external time source used.

Command: [SG] [x] [*]

Parameters: x = 0 for off
x = 1 for fast
x = 2 for medium
x = 3 for slow

Example: SG 2 <cr><lf>
turns on grid synchronization to medium.

Table 3-4 illustrates the interrelation between the current time interval and vertical grid synchronization. The time interval may be determined either by DIP switch setting, the Timer Mark Interval Command, or external time source. When grid synchronization is in effect, vertical grid lines print at the time intervals indicated in the following table:

Table 3-4: Vertical Grid Synchronization (time in seconds)

Time Interval	Fast	Medium	Slow	Time Source
.01	.01	.1	1	DIP S4 on
.1	.1	1	10	TT = .1
1	1	10	100	TT = 1
10	10	100	1000	TT = 10
60	60	600	6000	TT = 60
.1	.1	1	10	IRIG A
1	1	10	100	IRIG B
1	1	10	100	NASA 36
60	60	600	6000	IRIG H

The time interval ".01" is set via DIP switch located on the recorder's Utility Board; for all other time intervals DIP switch 4 must be set to off.

During grid synchronization, the vertical grid lines print in a fashion similar to tri-level event marking. That is, fast grid synchronization will correspond to the interval selected, medium grid synchronization will be ten times slower than the interval selected, and slow grid synchronization will be a hundred times slower than the interval selected. If tri-level event markers are activated, the grid lines will also correspond to either the shortest, intermediate or longest timer marks.



*Right System
Event Marker*

The *Right System Event Marker Command* allows you to select different output to be present on the right system event marker or to turn off the right marker. Sources for the event can be either a timer (internal or IRIG start pulse) or rear panel input (system event 2).

Command: [RM] [x] [*]
Parameters: x = 0 for off
 x = 1 for rear panel (See utility port.)
 x = 2 for timer
Example: RM 0 <cr><lf>
 turns the right marker off.

Note: See Appendix B for a chart of currently available right system event marker options for the MT-95000 and MT-96000 Recorders.

(MT-96000 only)

In the MT-96000 Recorder only, the right system event marker capability has been expanded to allow recording of tri-level event markers.

The tri-level event marker is based upon an internal timer or external time source to print a mark at three different intervals. The height of the marks vary accordingly, with the shortest mark corresponding to the briefest interval and the highest mark corresponding to the longest interval.

Where the three marks actually print is governed by the currently selected time interval or external time source. The time interval ".01" is set via DIP switch located on the recorder's Utility Board; for all other time intervals DIP switch 4 must be set to off. Table 3-5 shows the interrelation between the currently operative time interval and the time intervals at which the tri-level marks print.

Table 3-5: Tri-level Event Markers (time in seconds)

Time Interval	Shortest Mark	Medium Mark	Longest Mark	Time Source
.01	.01	.1	1	DIP S4 on
.1	.1	1	10	TT = .1
1	1	10	100	TT = 1
10	10	100	1000	TT = 10
60	60	600	6000	TT = 60
.1	.1	1	10	IRIG A
1	1	10	100	IRIG B
1	1	10	100	NASA 36
60	60	600	6000	IRIG H

For the MT-96000 only, the command format is as follows:

Command: [RM] [x] [*]
Parameters: x = 0 for off
 x = 1 for rear panel
 x = 2 for tri-level
 x = 3 for timer mark
Example: RM 2 <cr><lf>
 sets the right marker as tri-level.

Note: See Appendix B for a chart of currently available right system event marker options for the MT-95000 and MT-96000 Recorders.



Left System
Event Marker
(MT-96000 only)

In the MT-96000 Recorder only, the *Left System Event Marker Command* also represents an expanded capability. The MT-96000 can record tri-level, external, or manual events, or the left marker can be turned off.

The tri-level event marker is based upon an internal timer or external time source to print a mark at three different intervals. The height of the marks vary accordingly, with the shortest mark corresponding to the briefest interval and the highest mark corresponding to the longest interval. Where the three marks actually print is governed by the currently operative time interval. Refer to Table 3-5 for the currently available tri-level options.

You can also enter an event source externally from the rear panel or manually pulse it via the front-panel Event Key.

For the MT-96000 only, the command format is as follows:

Command: [LM] [x] [*]
Parameters: x = 0 for off
 x = 1 for front or rear panel
 x = 2 for tri-level
Example: LM 2 <cr><lf>
 sets the left marker as tri-level.

Note: See Appendix B for a chart of currently available left system event marker options for the MT-95000 and MT-96000 Recorders.



Service Request

The *Define Service Request Command* allows a GPIB controller to define the conditions upon which the MT-95000 or MT-96000 will send a service request to the host. Upon receiving a service request, the host performs a serial poll in search of the device(s) that has requested service; the device that has been enabled and addressed responds with a status byte (STB) message. The status byte returned by the recorder contains information as to whether that recorder requested service and, if so, the reason.

This command (MB) defines the status byte; the default value of this byte is 00 (off). The mask byte is created by adding the decimal equivalents for those reasons that the MT-95000 or MT-96000 will cause a service request (SRQ) over the GPIB interface.

Command: [MB] [x] [*]

Parameters: x = the decimal value of the 8-bit mask byte

Example: MB 3

causes the MT-95000/MT-96000 to send a service request (SRQ) to the host over the GPIB interface in the event of an interlock situation (paper out/door open), a command or data error, or both.



System Default

The *System Default Command* defaults all operating parameters to the factory default settings (listed at the beginning of this section).

Command: [DF] [*]

Parameters: none



Error/Status

The *Error/Status Command* is a query only that allows the host to obtain key information to aid program troubleshooting or find out when an operation has been completed. Upon receiving this command, the MT-95000/MT-96000 returns information on errors and completion status up to the point of receiving the ER Command in the form of a string of characters (either 0 for no or 1 for yes). At the present time, this string is four characters long and provides the following information:

- The first character indicates whether or not there is a command format/header error. The recorder will indicate a command format/header error if it receives an invalid command header or a command string with improper or unnecessary fields.

- The second character indicates whether or not there is a command data error. A command data error occurs when command data is out of range, invalid, etc.
- The third character provides data capture or background data capture completion status. The recorder will indicate data capture or background data capture completion status upon completion of a triggered acquisition. This status is cleared upon receiving a Background Capture Arm (Acquire) Command (AC).
- The fourth character provides operation completion status. This is indicated upon completion of any operation or mode that requires informing the host that the function is completed. For example, Data Playback Mode uses this feature.

Upon completion of the query, all four characters are cleared to zero.

Command: [ER] ? [*]
 Parameters: none (query only)
 Sample Response: 0101 <cr><lf>
 indicates that there is a command data program error and the operation is complete.

Table 3-6: Channel Setup Commands

<i>Header</i>	<i>Function</i>
CP	Change coupling (DC or ground) for an analog channel
VO	Set full-scale volt range
ZE	Position zero volts (ground) on chart
PO	Change signal polarity (normal or inverted)
CA	Calibrate all analog channels
AE	Annotate channel with alphanumerics or event marker
CR	Enable or disable reporting on signal conditioner for a channel
PL	Lift pen (disable printing) for an analog channel
NC	Define numeric calibration of each channel

The *Channel Setup Commands* control how signals and related data are presented on the chart.

Signal Coupling

The *Signal Coupling Command* changes the coupling on the recorder for any one of the analog channels to either DC signal or ground. That is, it specifies to either accept or ground the channel's input signal.

Command: [CP] [n],[x] [*]
Parameters: n = channel number (1 to 16)
 x = 1 for DC signal in
 x = 2 for ground
Example: CP 8,1 <cr><lf>
 specifies signal in for channel 8.

Voltage Range

The *Voltage Range Command* defines the volts full scale for any of the individual channels. If the Master Gain Control is active, the Range Command is used only for channel 1 and all channels are set for the values specified for channel 1. If External Signal Conditioner Control is active, the Range Command should not be used at all, since the full-scale voltage for all channels is set to 0.5 volts to accommodate the requirements of the external signal conditioners.

The voltage range is determined by gain source. The choices are as follows:

0.50 volts to 1.00 volts in .05-volt increments
1.00 volts to 5.00 volts in .10-volt increments
5.00 volts to 25.0 volts in .50-volt increments
26.0 volts to 40.0 volts in 1.0-volt increments

Command: [VO] [n],[y] [*]
Parameters: n = channel number (1 to 16)
 y = voltage in 4-byte string format
 (0.50 to 40.0 volts in decimal form)
Example: VO 2,25.0 <cr><lf>
 sets channel 2 for an input signal of 25 volts.

Zero Position

The *Zero Position Command* defines the position of 0 volts (ground) on the chart. To position zero volts, you specify the distance from the right edge of the channel via the numerical offset. In effect, this positions the waveform within the channel.

Command: [ZE] [n],[x] [*]
Parameters: n = channel number (1 to 16)

x = offset as specified numerically via integers 0 through 4095

Example: ZE 3,2048 <cr><lf>
places zero position in the middle of Channel 3.

Signal Polarity

The *Signal Polarity Command* changes the polarity for any of the analog channels represented on the chart. Polarity can be normal or inverted.

Command: [PO] [x],[y] [*]

Parameters: x = channel number (1 to 16)
y = N for normal polarity
y = I for inverted polarity

Example: PO 1,I <cr><lf>
inverts the polarity of signal 1 on the chart.

Analog Calibration

The *Analog Channel Calibration Command* causes the MT-95000/MT-96000 to perform an automatic and extremely accurate gain self-calibration for all analog channels. This procedure tests and corrects the baseline offset for each range and annotates the chart with the ground reference and calibration factor for each channel.

Command: [CA] [*]

Parameters: none

Interchannel Annotation

The *Interchannel Annotation/Event Marker Command* specifies whether alphanumeric data, an event marker, or nothing will print in the interchannel buffer.

Alphanumeric content is entered or edited via the Editing Interchannel Text Buffer Command from within the Analog Real-time Recorder Mode and is described in that section of this manual.

Command: [AE] [n],[x] [*]

Parameters: n = channel number (1 to 16)
x = 0 for no annotation or marker
x = 1 for alphanumeric annotation
x = 2 for an event marker

Example: AE 2,2 <cr><lf>
places an event marker with channel 2.

Signal Conditioner

The *Signal Conditioner Reporting Command* defines which channels will have signal conditioner reporting in the interchannel annotation buffer.

Command: [CR] [n],[x] [*]
Parameters: n = channel number (1 to 16)
 x = 0 for off
 x = 1 for on
Example: CR 2,0 <cr><lf>
 disables signal conditioner reporting on channel 2.

Pen Lift

The *Pen Lift Command* enables or disables chart printing for any of the analog channels. (The name of the command is a hold-over from old recorder technology; no pen is actually lifted.)

Command: [PL] [n],[y] [*]
Parameters: n = channel number (1 to 16)
 y = U for lifted (no printing)
 y = D for down (print/record)
Example: PL 1,D <cr><lf>
 enables printing of trace for channel 1.

Numeric Calibration

The *Numeric Calibration Command* defines the calibration for each channel in the numeric output modes, Data Logger and Numeric Playback. (This calibration does not adjust automatically upon a change in the volts command.) The conversion factors represent the values of the left and right edges of the waveform in the selected channel. These values are used to convert the waveform data into tabular numeric columns of data.

With this command you specify the left edge value and sign, the right edge value and sign, and the exponent and sign.

Command: [NC] [n],[lv],[ls],[rv],[rs],[e],[s] [*]
Parameters: n = channel number (1 to 16)
 lv, rv = four-digit integer (0000 to 9999)
 ls, rs = sign (+ or -)
 e = one-digit integer exponent (0 to 4)
 s = sign of exponent (controls decimal placement)
Example: NC 1,5000,+,5000,-,1,+ <cr><lf>
 specifies +50,000 to -50,000 degrees for channel 1.

Table 3-7: Grid Setup Commands

Header	Function
PR	Turn major grids on or off
MN	Turn minor grids on or off
AI	Enable or disable printing of signal identifier

The *Grid Setup Commands* determine whether and how grids will be printed during recording.

Note: Grids for the MT-96000 Recorder are customized for medical applications.



Print Control

The *Print Control Command* defines whether the major chart grid will be printed during recorder modes. This grid contains 10 major divisions.

Command: [PR] [x] [*]
 Parameters: x = + for grid on
 x = - for grid off
 Example: PR + <cr><lf>
 turns the grid on.



Minor Divisions

The *Minor Divisions Command* defines whether minor grid divisions will be printed during recorder chart modes. There are 50 minor grid divisions.

Command: [MN] [x] [*]
 Parameters: x = + for minor divisions on
 x = - for minor divisions off
 Example: MN + <cr><lf>
 turns the minor divisions on.



Automatic Identification

The *Automatic Identification Command* enables or disables the repetitive (approximately once per page) printing of signal identification. In non-overlapped formats, the identification number is printed in each channel, which is particularly helpful if the channels are no longer in numerical order. In overlapped formats, the identification number is printed on each waveform.

Command: [AI] [x] [*]
Parameters: x = 1 to enable automatic identification
x = 2 to disable automatic identification
Example: AI 1 <cr><lf>
enables automatic identification.

Table 3-8: Acquire Setup Commands

<i>Header</i>	<i>Function</i>
SR	Set sample rate for data capture
SV	Define storage method and window size for data capture

The *Acquire Setup Commands* determine how an acquisition (data capture) is to be performed. For more information on data capture and playback, refer to the *MT-95000/MT-96000 Operations Manual*.

Note: The MT-95000 and MT-96000 Recorders require installation of the DC-950 Data Capture option to perform any data capture or playback.

Sample Rate

The *Sample Rate Command* allows you to change the sample rate for data capture. The MT-95000 or MT-96000 can sample data up to 200 kHz per channel. The rate should be at least 10 times the input frequency.

Command: [SR] [x] [*]
Parameters: x = 1 for 200 kHz
x = 2 for 100 kHz
x = 3 for 50 kHz
x = 4 for 40 kHz
x = 5 for 25 kHz
x = 6 for 20 kHz
x = 7 for 10 kHz
x = 8 for 5 kHz
x = 9 for 1 kHz
Example: SR 2 <cr><lf>
sets the sample rate to 100 kHz per channel.

Storage Method

The *Storage Method Command* allows you to specify how you want analog data to be stored during data capture. The first, and most common, method is to allow up to 128K for each channel. If you want an expanded view, you can specify up to 512K for each channel, but only for 1/4 of the channels available. That is, only the first channel of each ADC module will be stored.

Valid window sizes:

Method	Valid size
1 x 512K storage	4 to 512 K
4 x 128K storage	4 to 128 K

Command: [SV] [x],[y] [*]

Parameters: x = 0 for 128K memory for each channel
x = 1 for 512K memory for the first channel in each bank
y = number of kilobytes per sample for one window (must be a multiple of 4)

Example: SV 0,100 <cr><lf>
saves all channels (method 1) with a sample of 100K for each window.

Table 3-9: Trigger Setup Commands

Header	Function
TS	Define trigger source
TL	Define trigger level and slope
TP	Define trigger position

The *Trigger Setup Commands* define the source, characteristics, and uses of triggers during recorder operation.

Trigger Source

The *Trigger Source Command* defines the active source of a trigger, which is a mechanism that enables the recorder either to begin operation or alter operation in response to various stimuli. The source of a trigger can be via the manual Trigger Key, externally generated by TTL pulse or switch closure, from the host, or sensed in the selected analog channel.

Command: [TS] [x] [*]
Parameters: x = 1 for manual
 x = 2 for external
 x = 3 for host
 x = 4 for analog
 x = 5 for manual or external
 x = 6 for manual or host
 x = 7 for manual or analog

Example: TS 6 <cr><lf>
 specifies that a trigger can be set manually via
 the recorder's trigger button or by command
 from the host.

Trigger Level/Slope

If a trigger is to have an analog source, the *Trigger Level/Slope Command* defines the current setup of the analog trigger. That is, it defines the active channel (for each bank) and the slope and voltage level at which the trigger occurs. Voltage level is specified as a percentage of full scale.

Command: [TL] [x],[y],[z],[r] [*]
Parameters: x = analog bank (specified as A, B, C, or D)
 y = the active channel in the bank or off (1 to 16, or 0 for off)
 z = the slope (R for rise, F for fall, E for either)
 r = voltage level as a percentage (0 to 100%)

Example: TL A,2,R,50 <cr><lf>
 defines the active trigger channel for Bank A to
 be channel 2 and specifies that the trigger is to
 occur on the rising slope at 50% of full scale.

Only one trigger channel may be selected per analog channel bank:

Bank A: (Channels 1 through 4 or off)
Bank B: (Channels 5 through 8 or off)
Bank C: (Channels 9 through 12 or off)
Bank D: (Channels 13 through 16 or off)

Trigger Position

The *Trigger Position Command* allows the user to modify the type of trace performed during data capture.

Command: [TP] [x] [*]
Parameters: x = 0 for start trace
 x = 1 for center trace
 x = 2 for end trace

Example: x = 3 for percentage (00 through 99)
TP 0 <cr><lf>
 starts the trace at the trigger.

Table 3-10: Playback Setup Commands

<i>Header</i>	<i>Function</i>
XY	Select x and y channels
MG	Specify reduction or magnification of playback
PP	Specify percentage of playback

The *Playback Setup Commands* determine how data will be played out on the chart during data playback. For more information on data capture and playback, refer to the *MT-95000/MT-96000 Operations Manual*.

Note: The MT-95000 and MT-96000 Recorders require installation of the DC-950 Data Capture option to perform any data capture or playback.

X and Y Channels

The MT-95000/MT-96000 is capable of producing x/y plots of two captured signals. The *X and Y Channels Command* specifies which channel will be x and which will be y when plotted.

Command: [XY] [x],[y] [*]
Parameters: x = 1 through 16 for x channel
 y = 1 through 16 for y channel
Example: XY 1,8 <cr><lf>
 sets x and y to channels 1 and 8.

Magnification The *Magnification Command* expands or compresses data during playback. Normally, data is played back at times 1.

Command: [MG] [x] [*]
Parameters: x = 1 for times 1
 x = 2 for times 2
 x = 3 for times 4
 x = 4 for times 8
 x = 5 for times .5
 x = 6 for times .25

Example: MG 2 <cr><lf>
 magnifies the data by 2 times.



*Playback
Percentage*

The *Playback Percentage Command* alters the amount of playback data to be output on the chart. You specify a start point as a percentage and an end point as a percentage. A complete playback is defined as 0 to 100%.

Command: [PP] [x],[y] [*]
Parameters: x = 0 to 99 in 1% increments (start)
 y = 1 to 100 in 1% increments (end)
 x < y
Example: PP 0,100 <cr><lf>
 specifies full playback of acquired data.

Table 3-11: Exit Setup Mode Command

<i>Header</i>	<i>Function</i>
EX	Exit System Setup Mode



*Exit Setup
Mode*

The *Exit Setup Mode Command* causes the recorder to leave the System Setup Mode and to return to Idle Mode. This command is required at the end of system setup.

Command: [EX] [*]
Parameters: none
Example: EX <cr><lf>

From Idle Mode you can enter any of the modes of operation. Sections 3-3 through 3-6 describe the various modes, the commands that enter the recorder into each mode, and the commands that are available from within each mode.

Charts in these sections list the commands available to each mode, while descriptions and examples of the commands are provided either in the appropriate section or in Section 3-2 where system setup commands are described.

Analog Real-time Recorder Mode

The standard use and main operation of the MT-95000 and MT-96000 Recorders is to be an analog stripchart recorder.

 Enter Analog
Real-time
Mode

Send the following command from the host to the recorder to begin analog real-time recording and to specify the chart format:

Command: [RT] [x] [*] (where x is a chart format)
Parameters: x = 1 for an 8-channel grid with one signal each
 x = 2 for 4-channel grids with two signals each
 x = 3 for 2 overlap grids, each with four signals each
 x = 4 for 12-channel grids with one signal each**
 x = 5 for 16-channel grids with one signal each**
 x = 6 for 2 overlap grids each with six or eight signals each**
Example: RT 1 <cr><lf>
 informs the recorder to enter basic 8-channel mode.

** Requires additional A/D board option(s).

Table 3-12: Analog Real-time Recorder Commands

<i>Header Function</i>	
ST	Start or stop the recorder output (toggle)
RU	Start recorder output
HA	Halt recorder output
SP	Change and set speed
ID	Label the waveforms with numeric identification
SC	Turn system log channel print control on or off
ES	Edit system log channel buffer
PB	Control printing of interchannel text buffer
ED	Edit interchannel buffers
TT	Set timer marker interval
SE	Turn the system event marker(s) on or off
RM	Control right system event marker
LM	Control left system event marker (MT-96000 only)
AC	Arm/disarm background data capture
ER	Report on MT-95000/MT-96000 status
EX	Exit Analog Real-time Recorder Mode to Idle Mode
<i>Channel Group Commands</i>	
<i>Header Function</i>	
CP	Change coupling (DC or ground) for an analog channel
VO	Set full-scale volt range
ZE	Position zero volts (ground) on chart
PO	Change signal polarity (normal or inverted)
CA	Calibrate all analog channels
CR	Enable/disable signal conditioner reporting
PL	Lift pen (disable printing) for an analog channel
<i>Acquire Setup Commands</i>	
<i>Header Function</i>	
SR	Set sample rate for data capture
SV	Define storage method and window size
<i>Trigger Setup Commands</i>	
<i>Header Function</i>	
TS	Define trigger source
TL	Define trigger level
TP	Define trigger position

After entering Analog Real-time Recorder Mode, you can select a variety of output types or operating conditions. When in this mode, there are four command groups that determine recording characteristics:

- Real-time Recorder Commands
- Channel Setup Commands
- Trigger Setup Commands
- Acquire Setup Commands

All of these commands and their functions are listed in Table 3-12. The Analog Real-time Recorder commands are fully described in this section. The Channel Setup, Trigger Setup, and Acquire Setup commands are fully described in Section 3-2 under “System Setup Mode,” but they are also available while in the Analog Real-time Recorder Mode. Refer to Section 3-2 for descriptions and examples of these commands.

Note: The Acquire and Trigger Setup Commands are applicable only if data capture is to be used.

Analog Real-Time Recorder Commands



Start/Stop

The *Start/Stop Toggle Command* starts or stops the motor, thus controlling recorder chart output. This is a toggle command, meaning that the same command changes the recorder state from the one it is currently in to the other. That is, if the recorder is running, ST will stop it; if it is not running, ST will start it. (There are also separate RUN/HALT commands available.)

Command: [ST] [*]
Parameters: none
Example: ST <cr><lf>



Run and Halt

The *Run and Halt Commands* control the running of the recorder while in the Analog Real-time Recorder Mode. This command is similar to the Start/Stop Toggle Command.

Command: [RU] [*] or [HA] [*]
Parameters: none
Example: RU <cr><lf>
 starts analog chart recording.

Set/Change Motor Speed

The *Set/Change Motor Speed Command* changes the current motor speed. The default speed is 25 millimeters per second (mm/sec); valid speeds are up to 200 mm/sec, plus 500 mm/sec.

Command: [SP] [x],[y] [*]

Parameters: x is an integer from 1 to 200, or 500

y is the range: 1 for mm/second

2 for mm/minute

3 for mm/hour

Example: SP 100,1 <cr><lf>

sets the speed at 100 millimeters per second.

Identification

The *Identification (ID) Command* causes a numeric ID to be printed on each signal to clearly identify which trace represents which input signal. This is very useful during overlap recording.

Command: [ID] [*]

Parameters: none

Example: ID <cr><lf>

System Log Channel

The *System Log Channel Command* controls whether or not the system log channel on the left edge of the chart will print.

Command: [SC] [x] [*]

Parameters: x = 0 turns printing off

x = 1 turns printing on

Example: SC 1 <cr><lf>

turns the system log on.

Edit System Log Channel

The *Edit System Log Channel Command* allows editing of the last thirty characters of the system log channel.

Command: [ES] [s] [*]

Parameters: s = the text string in quotes

Example: ES "System Log" <cr><lf>

causes "System Log" to be printed in the last 30 character spaces of the system log.**

Interchannel Text Buffer

The *Interchannel Text Buffer Command* controls how the interchannel text buffers are printed in the analog record.

Command: [PB] [x] [*]

Parameters: x = 0 turns printing off

x = 1 causes text buffers to be printed once
x = 2 causes printing to be repeated
Example: PB 1 <cr><lf>
causes text buffers to be printed once.

Edit Text Buffer

The *Edit Interchannel Text Buffer Command* allows editing of each individual text buffer. (You may have up to 16 buffers.) Each interchannel buffer is 120 characters in length.

Command: [ED] [x][s] [*]
Parameters: x = the buffer number (1 to 16)
s = the text string in quotes
Example: ED 1, "Channel 1" <cr><lf>
causes "Channel 1" to be printed beside channel 1 on the chart.**

** If you want to insert quotation marks within the buffer, enter double quotation marks. For example, ""Channel 1"" will print as: "Channel 1"

Timer Mark Interval

The *Timer Mark Interval Command* sets the time interval for the printing of timing marks along the left edge of the chart paper or turns off this feature.

Command: [TT] [x] [*]
Parameters: x = 0 for .1 seconds
x = 1 for 1 second
x = 2 for 10 seconds
x = 3 for 60 seconds
x = 4 for off
Example: TT 1 <cr><lf>
causes the printing of a timing mark every second.

System Event Marker

The *System Event Marker Command* enables or disables printing of the system event markers during recorder output. These markers are located on the right and left sides of the chart.

Command: [SE] [x],[s] [*]
Parameters: x = L for left
x = R for right
s = 0 for off
s = 1 for on

Example: SE L,0 <cr><lf>
turns the left system event marker off.



*Right System
Event Marker*

The *Right System Event Marker Command* allows you to select different output to be present on the right system event marker or to turn off the right marker. Sources for the event can be either a timer (internal or IRIG start pulse) or rear panel input (system event 2).

Command: [RM] [x] [*]
Parameters: x = 0 for off
 x = 1 for rear panel (See utility port.)
 x = 2 for timer
Example: RM 0 <cr><lf>
 turns the right marker off.

Note: See Appendix B for a chart of currently available right system event marker options for the MT-95000 and MT-96000 Recorders.

(MT-96000 only)

In the MT-96000 Recorder only, the right system event marker capability has been expanded to allow recording of tri-level event markers.

The tri-level event marker is based upon an internal timer or external time source to print a mark at three different intervals. The height of the marks vary accordingly, with the shortest mark corresponding to the briefest interval and the highest mark corresponding to the longest interval.

Where the three marks actually print is governed by the currently selected time interval or external time source. The time interval ".01" is set via DIP switch located on the recorder's Utility Board; for all other time intervals DIP switch 4 must be set to off. Table 3-13 shows the interrelation between the currently operative time interval and the time intervals at which the tri-level marks print.

Table 3-13: Tri-level Event Markers (time in seconds)

Time Interval	Shortest Mark	Medium Mark	Longest Mark	Time Source
.01	.01	.1	1	DIP S4 on
.1	.1	1	10	TT = .1
1	1	10	100	TT = 1
10	10	100	1000	TT = 10
60	60	600	6000	TT = 60
.1	.1	1	10	IRIG A
1	1	10	100	IRIG B
1	1	10	100	NASA 36
60	60	600	6000	IRIG H

For the MT-96000 only, the command format is as follows:

Command: [RM] [x] [*]

Parameters: x = 0 for off

x = 1 for rear panel

x = 2 for tri-level

x = 3 for timer mark

Example: RM 2 <cr><lf>

sets the right marker as tri-level.

Note: See Appendix B for a chart of currently available right system event marker options for the MT-95000 and MT-96000 Recorders.

 **Left System Event Marker**
(MT-96000)

In the MT-96000 Recorder only, the *Left System Event Marker Command* also represents an expanded capability. The MT-96000 can record tri-level, external, or manual events, or the left marker can be turned off.

The tri-level event marker is based upon an internal timer or external time source to print a mark at three different intervals. The height of the marks vary accordingly, with the shortest mark corresponding to the briefest interval and the highest mark corresponding to the longest interval. Where the three marks actually print is governed by the currently operative time interval. Refer to Table 3-13 for the currently available tri-level options.

You can also enter an event source externally from the rear panel or manually pulse it via the front-panel Event Key.

For the MT-96000 only, the command format is as follows:

Command: [LM] [x] [*]
Parameters: x = 0 for off
 x = 1 for front or rear panel
 x = 2 for tri-level
Example: LM 2 <cr><lf>
 sets the left marker as tri-level.

Note: See Appendix B for a chart of currently available left system event marker options for the MT-95000 and MT-96000 Recorders.

Background Data Capture

The *Background Data Capture Command* arms or disarms the DC-950 data capture operation. (Your recorder must be equipped with the DC-950 Data Capture option in order to perform this function.)

The data capture feature allows the MT-95000/MT-96000 to record (capture) signals displayed during analog real-time recording. This enables you to view the chart representation of the signals as they occur, as well as to review representation of the signals in an expanded form at a later time.

The default condition whenever Analog Real-time Recorder Mode is entered is for the data capture feature to be disarmed. Use the AC command to turn this feature on and begin data capture.

Command: [AC] [r] [*]
Parameters: r = 0 for disarm
 r = 1 for arm
Example: AC 1 <cr><lf>
 arms the MT-95000/MT-96000 for data capture.

After performing a data capture, you should use the ERR/STATUS query to determine when a background capture has been completed.

Refer to the *MT-95000/MT-96000 Operations Manual* and to Section 3-4 in this manual for detailed information on data capture.



Error/Status

The *Error/Status Command* is a query only that allows the host to obtain key information to aid program troubleshooting or find out when an operation has been completed. Upon receiving this command, the MT-95000/MT-96000 returns information on errors and completion status up to the point of receiving the ER Command in the form of a string of characters (either 0 for no or 1 for yes):

- The first character indicates whether or not there is a command format/header error.
- The second character indicates whether or not there is a command data error.
- The third character provides data capture or background data capture completion status.
- The fourth character provides operation completion status.

Once the query is completed, all four characters are cleared to zero. Refer to Section 3-2 under “System Setup Mode” for more information about this command.

Command: [ER] ? [*]

Parameters: none (query only)

Sample Response: 0101 <cr><lf>

indicates that there is a command data error and the operation is complete.



Exit Analog Real-time Mode

The *Exit Analog Real-time Recorder Mode Command* ends analog real-time recording and returns the recorder to Idle Mode, where it awaits a new mode command header.

Command: [EX] [*]

Parameters: none

Example: EX <cr><lf>

Data Logger Mode

The MT-95000 and MT-96000 Recorders have the capability to be eight-channel data loggers that output real-time data in numeric format according to the values specified by the Numeric Calibration Command during system setup. This command is described in Section 3-2 under "System Setup Mode."

The commands from the host when the recorder is in this mode are similar to those when the recorder is in Analog Real-time Recorder Mode. Refer to the *MT-95000/MT-96000 Operations Manual* for more information on the Data Logger Mode.

Enter Data Logger Mode

To enter Data Logger Mode:

Command: [DL] [*]
Parameters: none
Example: DL <cr><lf>

All of the commands used in Data Logger Mode and their functions are listed in Table 3-14. The Data Logger commands are fully described in this section. The Channel Setup, Acquire Setup, and Trigger Setup commands are fully described in Section 3-2 under "System Setup Mode," but they are also available while in Data Logger Mode. Refer to Section 3-2 for descriptions and examples of these commands.

Data Logger Commands

Start/Stop

The *Start/Stop Toggle Command* starts or stops the motor, thus controlling numeric data logging output. This is a toggle command, meaning that the same command changes the recorder state from the one it is currently in to the other. That is, if the recorder is running, ST will stop it; if it is not running, ST will start it. (There are also separate RUN/HALT commands available.)

Command: [ST] [*]
Parameters: none
Example: ST <cr><lf>

Table 3-14: Data Logger Commands

<i>Header</i>	<i>Function</i>
ST	Start or stop the recorder output (toggle)
RU	Start recorder output
HA	Halt recorder output
SP	Change and set logging speed
AC	Arm/disarm background data capture
ER	Report on MT-95000/MT-96000 status
EX	Exit Data Logger Mode to Idle Mode

<i>Channel Group Commands</i>	
<i>Header</i>	<i>Function</i>
CP	Change coupling (DC or ground) for an analog channel
VO	Set full-scale volt range
ZE	Position zero volts (ground) on chart
PO	Change signal polarity (normal or inverted)
CR	Enable or disable reporting on signal conditioner for a channel
PL	Lift pen (disable printing) for an analog channel

<i>Acquire Setup Commands</i>	
<i>Header</i>	<i>Function</i>
SR	Set sample rate for data capture
SV	Define storage method and window size for data capture

<i>Trigger Setup Commands</i>	
<i>Header</i>	<i>Function</i>
TS	Define trigger source
TL	Define trigger level
TP	Define trigger position

Note: The Acquire and Trigger Setup Commands are applicable only if data capture is to be used.

Run and Halt The *Run and Halt Commands* control the running of the recorder while in Data Logger Mode. This command is similar to the Start/Stop Toggle Command.

Command: [RU] [*] or [HA] [*]

Parameters: none

Example: RU <cr><lf>
starts data logger real-time numeric recording.

Set/Change Logging Speed The *Set/Change Logging Speed Command* changes the current data logging speed to the selected range. In the Data Logger Mode, speed is determined in a different manner than in other modes. In other modes, speed is determined as millimeters of print per unit of time. In Data Logger mode, speed is determined as a line of data printed during a particular span of time. Data logging speed can be specified as a line of data printed every so many milliseconds, seconds, or minutes, up to a maximum speed of one line every 175 milliseconds.

Command: [SP] [x],[y] [*]

Parameters: x is an integer in the ranges specified

y = 1 for milliseconds (175-999)

y = 2 for seconds (001-999)

y = 3 for minutes (001-999)

Example: SP 190,1 <cr><lf>
sets speed at one line every 190 milliseconds.

Background Data Capture The *Background Data Capture Command* arms or disarms the DC-950 data capture operation. (Your recorder must be equipped with the DC-950 Data Capture option in order to perform this function.)

The data capture feature allows the MT-95000/MT-96000 to record (capture) signals displayed during data logger real-time recording. This enables you to view the numeric representation of the signals as they occur, as well as to review representation of the signals in an expanded form at a later time.

The default condition whenever Data Logger Mode is entered is for the data capture feature to be disarmed. Use the AC command to turn this feature on and begin data capture.

Command: [AC] [r] [*]

Parameters: r = 0 for disarm

r = 1 for arm

Example: AC 1 <cr><lf>
 arms the MT-95000/MT-96000 for data
 capture.

After performing a data capture, you should use the ERR/
STATUS query to determine when a background capture has
been completed.

Refer to the *MT-95000/MT-96000 Operations Manual* and to
Section 3-4 of this manual for more information on data capture.



Error/Status

The *Error/Status Command* is a query only that allows the host
to obtain key information to aid program troubleshooting or find
out when an operation has been completed. Upon receiving this
command, the MT-95000/MT-96000 returns information on
errors and completion status up to the point of receiving the ER
Command in the form of a string of characters (either 0 for no or
1 for yes):

- The first character indicates whether or not there is a
command format/header error.
- The second character indicates whether or not there is a
command data error.
- The third character provides data capture or background
data capture completion status.
- The fourth character provides operation completion
status.

Once the query is completed, all four characters are cleared to
zero. Refer to Section 3-2 under “System Setup Mode” for
more information about this command.

Command: [ER] ? [*]
Parameters: none (query only)
Sample Response: 0101 <cr><lf>
 indicates that there is a command data
 error and the operation is complete.



Exit Data Logger Mode

The *Exit Data Logger Mode Command* ends data logger numeric
real-time recording and returns the recorder to the Idle Mode,
where it awaits a new mode command header.

Command: [EX] [*]
Parameters: none
Example: EX <cr><lf>

Data Capture Mode *(DC-950 option required)*

The Data Capture Mode causes the MT-95000/MT-96000 to perform a data capture sequence wherein analog data is digitized and stored in memory. The data capture is performed according to current acquisition settings, including sample rate, storage method, and window size. These settings are determined during system setup and are described in Section 3-2 under “System Setup Mode.” For additional information on the Data Capture Mode, refer to the *MT-95000/MT-96000 Operations Manual*.

The data capture is completed when the window is filled to the specified size and the trigger condition has been met.



Enter Data
Capture
Mode

To enter Data Capture Mode, issue the following command:

Command: [AC] [*]
Parameters: none

During the data capture, commands are available to exit or abort acquisition or to determine when acquisition is completed.

Data Capture Commands

Table 3-15: Acquire (Data Capture) Commands

Header	Function
ER	Request error or completion status
EX	Exit (abort) acquisition and return to Idle Mode



Error/Status

The *Error/Status Command* is a query only and allows the host to obtain key information to aid program troubleshooting or find out when an operation has been completed. Upon receiving this command, the recorder returns a string of characters (in the form of either 0 for no or 1 for yes) that contain this status information. At the present time, this string is four characters long and is fully described in Section 3-2 under "System Setup Mode."

The third character provides data capture or background data capture completion status. The recorder will indicate data capture or background data capture completion status upon completion of a triggered acquisition. This status is cleared upon receiving a Background Capture Arm Command (AC).

Command: [ER] ? [*]
Parameters: none (query only)
Sample Response: 0011 <cr><lf>
indicates that a data capture sequence has been completed.



Exit

The *Exit Command* allows the host to abort a data acquisition sequence that was started with the Background Capture Arm Command.

Command: [EX] [*]
Parameters: none

Data Playback Mode (DC-950 option required)

Data Playback Mode allows you to print stored data. The data is stored in digitized form but can be played out on the chart in a variety of formats.



Enter Data Playback Mode

To enter Data Playback Mode and specify the format in which data is to be played back, issue the following command:

Command: [PB] [x] [*]
Parameters: x = 1 for eight-channel format
x = 2 for four-channel format
x = 3 for two-channel format (overlap)
x = 4 for x/y format (plot)
x = 5 for numeric format

x = 6 for 12-channel format
 x = 7 for 16-channel format
 x = 8 for 12- or 16-channel overlap format
 Example: PB 1 <cr><lf>
 specifies that data is to be played back in eight-channel format.

Output does not begin until the Start or Run Command is sent. To determine when playback is completed, you can send the Error Status Command (ER). For additional information on the Data Playback Mode, refer to the *MT-95000/MT-96000 Operations Manual*.

Data Playback Commands

Table 3-16: Data Playback Mode Commands

Header	Function
ST	Start or stop the recorder output (toggle)
RU	Start recorder output
HA	Halt recorder output
ID	Label the signals with numeric identification
PB	Control printing of interchannel text buffer
ED	Edit interchannel buffers
ER	Request error or completion status
EX	Exit Data Playback Mode to Idle Mode

Start/Stop

The *Start/Stop Toggle Command* starts or stops the motor, thus controlling recorder chart output. This is a toggle command, meaning that the same command changes the recorder state from the one it is currently in to the other. That is, if the recorder is running, ST will stop it; if it is not running, ST will start it. (There are also separate RUN/HALT commands available.)

When a Start Command is sent, the recorder plays back as much data as has been stored by a previous data capture.

Command: [ST] [*]
Parameters: none
Example: ST <cr><lf>

Run and Halt

The *Run and Halt Commands* control the running of the recorder while in the Data Playback Mode. This command is similar to the Start/Stop Toggle Command.

When the Run Command is sent, the recorder plays back as much data as has been stored by a previous data capture.

Command: [RU] [*] or [HA] [*]
Parameters: none
Example: RU <cr><lf>
starts data playback.

Identification

The *Identification (ID) Command* causes a numeric ID to be printed on each signal to clearly identify which trace represents which input signal. This is very useful during overlap recording.

Command: [ID] [*]
Parameters: none
Example: ID <cr><lf>

Interchannel Text Buffer

The *Interchannel Text Buffer Command* controls how the interchannel text buffers are printed in the analog record.

Command: [PB] [x] [*]
Parameters: x = 0 turns printing off
x = 1 causes text buffers to be printed once
x = 2 causes printing to be repeated
Example: PB 1 <cr><lf>
causes text buffers to be printed once.

Edit Text Buffer

The *Edit Interchannel Text Buffer Command* allows editing of each individual text buffer. (You may have up to 16 buffers.) Each interchannel buffer is 120 characters in length.

Command: [ED] [x],[s] [*]
Parameters: x = the buffer number (1 to 16)
s = the text string in quotes
Example: ED 1, "Channel 1" <cr><lf>
causes "Channel 1" to be printed beside channel 1 on the chart.**

** If you want to insert quotation marks within the buffer, enter double quotation marks. For example, ““Channel 1”” will print as: “Channel 1”

Error/Status

The *Error/Status Command* is a query only and allows the host to obtain key information to aid program troubleshooting or find out when an operation has been completed. Upon receiving this command, the recorder returns a string of characters (in the form of either 0 for no or 1 for yes) that contain this status information. At the present time, this string is four characters long and is fully described in Section 3-2 under “System Setup Mode.”

The fourth character indicates operation completion status upon completion of any operation or mode that requires informing the host that the function is completed. In Data Playback Mode the recorder plays back as much data as was stored during the previous data capture. To determine when the playback is finished, the host can perform an error/status query.

Command: [ER] ? [*]
Parameters: none (query only)
Sample Response: 0001 <cr><lf>
indicates that data playback has been completed.

Exit Data Playback Mode

The *Exit Data Playback Mode Command* ends data playback and returns the recorder to Idle Mode, where it awaits a new mode command header.

Command: [EX] [*]
Parameters: none
Example: EX <cr><lf>

Digital Data Recorder Mode (DI-488-950 option required)

Note: The Digital Data Recorder Mode requires that the DI-488-950 Digital Interface option be installed in the MT-95000/MT-96000 and is available only to GPIB interface applications.

The MT-95000 and MT-96000 Recorders can record signals that have their source from the host and are transferred over the communications interface. This data may have been uploaded from the recorder or acquired from another source. The host can transfer both command and waveform data in digital form and all recorder chart formats that are available for analog real-time recording are also available for digital real-time recording. With the exception of analog control commands, most of the system parameters are available in this mode. Digital data is similar in resolution and specification as analog real-time recording. Data should be transferred as 12-bit data to match the resolution of analog data.

 Enter Digital Data Mode

To enter this mode and specify a format, send the following command:

Command: [DS] [x] [*]

Parameters: x = 1 for eight-channel grids with one signal each
x = 2 for four-channel grids with two signals each
x = 3 for two-channel grids with four signals each
x = 4 for twelve-channel grids with one signal each
x = 5 for sixteen-channel grids with one signal each
x = 6 for two-channel grids with eight signals each

Example: DS 1 <cr><lf>
specifies an eight-channel format for eight individual signals.

The information received from the host must be separated into data and control information. Therefore, the information is sent in either data or control packets, consisting of a header and the body:

- Header — a single ASCII byte header defining either a data or control packet. This shall be an ASCII “C” or “D”.
- Body — either data defined in data packets or a command sequence.
- [*] — terminator (EOI only).

Data received while in this mode is printed with a resolution of 1/16 millimeter per point. Thus, it will take 16 packets to print one millimeter of chart.

Data Packets

The data packet is the format in which all waveform data is transferred to the MT-95000/MT-96000 while in Digital Data Recorder Mode. The recorder prints the information upon receiving the data packet, which includes signal data and event marker information.

Digital data that is transferred within data packets may range from 0000 to 0FFFFH. The low end of this range is normally the right side of the channel and the high end is toward the left. You can use signal inversion to change this.

There are two types of data packets: full and single point.

Full Data Packets:

The full data packet contains signal (waveform) information and event marker information for *all* channels in the following format:

Byte 1	D — an ASCII “D” header representing data packet
Byte 2	<sp> — a space to separate the header from the information
Byte 3	E1 — eight bits of event marker information for channels 1 through 8

Byte 4	E2 — eight bits of event marker information for channels 9 through 16 (This byte, although sent, is ignored for formats with less than eight events.)
Byte 5 - n	Binary data byte pairs in low-byte/high-byte format. (The number of pairs in each packet (n) equals the number of signals available. Valid 12-bit data: 0000 through 0FFFH.)

Note: EOI should be attached to the last data byte of the packet.

The formula for the minimum number of bytes per full packet = $[4 + (n * 2)]$. The terminator may affect the total number of bytes, but an extra carriage return or linefeed attached to the data packets will not affect operation.

The E1 and E2 data bytes must be included in all data packets. Each data bit of this byte corresponds to a possible event marker that is to be recorded. The least significant bit (LSB) corresponds to the left event marker and so on. The MT-95000/MT-96000 records event markers or annotation between channels, as configured during system setup.

A different order of waveforms may be accomplished by re-ordering the waveform data in packets.

Single Channel Data Packet:

The single data packet contains one signal (waveform) data and event marker information. This allows the host a method for updating a single waveform while other waveforms use the previous point for updating the chart. The single data packet consists of the following format:

Byte 1	S — an ASCII “S” header representing a single data packet
Byte 2	<sp> — a space (or other valid character) to separate the header from the information
Byte 3	E1 — eight bits of event marker information for channels 1 through 8
Byte 4	E2 — eight bits of event marker information for channels 9 through 16 (This byte is ignored for formats with less than eight events.)

Byte 5	CN — binary channel number that the recorder will use for the data word
Byte 6,7	Data — binary data word in low-byte/high-byte format. (Valid 12-bit data: 0000 through 0FFFH.)

Note: EOI should be attached to the last data byte of the packet.

An example of a single-channel data packet:

Byte 1	S	header in ASCII (53H)
Byte 2	-	hyphen character
Byte 3	FF	binary byte that causes all 8 events to be in high position
Byte 4	00	event byte number 2 (ignored by recorder in 8-channel format)
Byte 5	02	binary number for channel 2
Byte 6	24	binary waveform data for channel 2 (LSB)
Byte 7	10	binary waveform data for channel 2 (MSB with an EOI = 1)

Control Packets

Control packet information contains the commands to be processed by the MT-95000/MT-96000 during Digital Data Recorder Mode. These commands are similar to those in other modes except that they must include the control header and be separated from the command by a space.

Format: [C] [command header] [parameters] [*]
 Example: C PB 2 (with EOI=1)
 executes print buffer control.

Digital Data Recorder Commands

Table 3-17: Digital Data Recorder Mode Commands

<i>Header</i>	<i>Function</i>
C ID	Label the waveforms with numeric identification
C SC	Turn system log channel print control on or off
C ES	Edit system log channel buffer
C PB	Control printing of interchannel text buffer
C ED	Edit interchannel buffers
C SE	Turn the system event marker(s) on or off
C PL	Lift pen (disable printing) for a channel
C PO	Change signal polarity (normal or inverted)
C MS	Control motor step
C EX	Exit Digital Recorder Mode to Idle Mode

 **Identification** The *Identification (ID) Command* causes a numeric ID to be printed on each signal to clearly identify which trace represents which input signal. This is very useful during overlap recording.

Command: [C] [ID] [*]
Parameters: none
Example: C ID (EOI = 1 on last byte)

 **System Log Channel** The *System Log Channel Command* controls whether or not the system log channel on the left edge of the chart will print.

Command: [C] [SC] [x] [*]
Parameters: x = 0 turns printing off
 x = 1 turns printing on
Example: C SC 1 (EOI = 1 on last byte)
 turns the system log on.

 **Edit System Log Channel** The *Edit System Log Channel Command* allows editing of the last thirty characters of the system log channel.

Command: [C] [ES] [s] [*]
Parameters: s = the text string in quotes

Example: C ES "System Log" (EOI = 1 on last byte)
causes "System Log" to be printed in the last
30 character spaces of the system log.**

 **Interchannel
Text Buffer**

The *Interchannel Text Buffer Command* controls how the inter-channel text buffers are printed in the output record.

Command: [C] [PB] [x] [*]
Parameters: x = 0 turns printing off
x = 1 causes text buffers to be printed once
x = 2 causes printing to be repeated
Example: C PB 1 (EOI = 1 on last byte)
causes text buffers to be printed once.

 **Edit Text
Buffer**

The *Edit Interchannel Text Buffer Command* allows editing of each individual text buffer. (You may have up to 16 buffers.) Each interchannel buffer is 120 characters in length.

Command: [C] [ED] [x],[s] [*]
Parameters: x = the buffer number (1 to 16)
s = the text string in quotes
Example: C ED 1,"Channel 1" (EOI = 1 on last byte)
causes "Channel 1" to be printed beside chan-
nel 1 on the chart.**

** If you want to insert quotation marks within the buffer, enter double quotation marks. For example, ""Channel 1"" will print as: "Channel 1"

 **System
Event Marker**

The *System Event Marker Command* enables or disables printing of the system event markers during recorder output. These markers are located on the right and left sides of the chart.

Command: [C] [SE] [x],[s] [*]
Parameters: x = L for left
x = R for right
s = 0 for off
s = 1 for on
Example: C SE L,0 (EOI = 1 on last byte)
turns the left system event marker off.



Pen Lift

The *Pen Lift Command* enables or disables printing of the signal on the chart. During digital recording, channels reside in numeric order from left to right on the chart.

Command: [C] [PL] [n],[y] [*]
Parameters: n = channel number (1 to 16)
y = U for lifted (no printing)
y = D for down (print/record)
Example: C PL 1,D (EOI = 1 on last byte)
enables printing of trace for channel 1.



Signal Polarity

The *Signal Polarity Command* changes the polarity for any of the analog channels represented on the chart. Polarity can be normal or inverted.

Command: [C] [PO] [x],[y] [*]
Parameters: x = channel number (1 to 16)
y = N for normal polarity
y = I for inverted polarity
Example: C PO 1,I (EOI = 1 on last byte)
inverts the polarity of signal 1 on the chart.



Motor Step

The *Motor Step Command* allows the host to advance chart output. Upon receiving this command, the recorder advances the paper a specified distance, resulting in the printing of a data point as a line continuation. You can control chart advancement down to a 1/16 millimeter increment, with one millimeter equaling 16 steps.

Command: [C] [MS] [x] [*]
Parameters: x = an ASCII integer in the range of 0001 to 4096
Example: C MS 16 (EOI = 1 on last byte)
advances the chart one millimeter.



Exit Digital Data Mode

The *Exit Digital Data Recorder Mode Command* ends digital recording and returns the recorder to Idle Mode, where it awaits a new mode command header.

Command: [C] [EX] [*]
Parameters: none
Example: C EX (EOI = 1 on last byte)

Data Transfer (Upload) *(DC-950 option required)*

The MT-95000 and MT-96000 Recorders have the ability to transfer acquired data to the host computer, where it can be archived or used for data analysis. The data is acquired by a snapshot and is stored in the MT-95000/MT-96000 memory in pure binary form. Binary transfer allows for fast data transfer and easy archival in the host computer system. This information may be converted to ASCII printable data by the host computer.

Waveform data has 12-bit resolution and thus may range from 0000H-0FFFFH (0-4095). Data is uploaded in low-byte/high-byte binary format; each sample point requires a word transfer. When interpreting uploaded data, the time period between sample points is determined by the sample rate. Each waveform can be uploaded on an individual basis.

The data transfer format differs depending on the active communication method: RS-232 uses ASCII data transfer; GPIB uses binary transfer for enhanced transfer capability.



*Enter Data
Transfer
Mode*

To enter Data Transfer Mode, send the following command:

Command: [XF] [*]
Parameters: none

Data Transfer Commands

Table 3-18: Data Transfer Mode Commands

<i>Header</i>	<i>Function</i>
RI	Request information about the acquisition (data capture memory).
WV	Select waveform(s) and initiate transfer.
EX	Exit Data Transfer Mode and return to Idle Mode.

 **Request
Information**

Before initiating an upload, the *Request Information Command* can be used to inquire about data capture status. The MT-95000/MT-96000 responds with information that the host can use to properly perform the transfer.

Command: [RI] [*]
Parameters: none
Example: RI <cr><lf>

Upon receiving this command, the recorder sends an ASCII string in the following format:

[nnn] number in ASCII of four ksample blocks
 available. Valid numbers are:
 '001' to '032' for 128K per channel
 '001' to '128' for 512K per channel
[x] method of data capture storage:
 '0' = 128K per channel
 '1' = 512K per channel (1/4 of channels only)
<cr><lf> terminator (always)

To properly receive this string, the host computer should send the command and take in all bytes from the MT-95000/MT-96000 up until the <cr><lf> terminator is received.

Sample Response: '003 0' <cr><lf>
 indicates that a 12K window was ac-
 quired and that the current data capture
 method is 4x128K storage.

 **Waveform
Transfer**

To start waveform from the MT-95000/MT-96000 to the host computer, the host sends the *Waveform Transfer Command*. The recorder responds with a header and a 4-kilosample block of data from the specified channel.

Command: [WV] [x],[y] [*]
Parameters: x = '01' - '16', to specify channel to transfer*
 y = '001' - '032' or '001' - '128'
 to specify which 4-kilosample block to transfer*
Example: WV 1,3 <cr><lf>
 causes the recorder to send the third 4-kilo-
 sample block of data from Channel 1.

* An error condition occurs if the channel number is invalid or a 4K block specified is greater than the number indicated in the

recorder's response to the RI Command. For example, if the storage method is 1x512K and the channel specified is '06', an error condition results since only channels 1, 5, 9, or 13 are valid for 1x512K storage. If an error condition occurs, the first 4K block of captured data from channel 1 will be sent, if available. Otherwise, an ASCII '00' will be sent indicating that there is no captured data for that channel or the data is invalid.

The recorder transfers a large amount of binary information in either of the following formats, depending on whether the communications interface is GPIB or RS-232.

In GPIB communications, the MT-95000/MT-96000 transfers binary information in the following format:

[xx]	channel in ASCII (will be '00' if there is no captured data available for that channel)
data	four kilosamples of data in low-byte/high-byte format (total number of bytes equals 8K since each data point consists of two binary bytes). Valid point is in the range of 0000 - 0FFF Hexidecimal.
EOI	terminator attached to the last bytes of transfer

In RS-232 communications, the MT-95000/MT-96000 transfers binary information in the following format:

[xx]	channel in ASCII (will be '00' if there is no captured data available for that channel)
data	four kilosamples of data in low-byte/high-byte format (total number of bytes equals 16K since each data point consists of four ASCII bytes). Valid point is in the range of '0000' - '4095' ASCII (decimal representation).
<cr><lf>	terminator attached to the last bytes of transfer

The host should check xx and if it is an ASCII '00', then there is no captured data for that channel or the data is invalid.

Exit Data Transfer Mode

The *Exit Data Transfer Mode Command* ends data transfer and returns the recorder to the Idle Mode, where it awaits a new mode command header.

Command: [EX] [*]
Parameters: none

Line Printer Modes

The MT-95000 and MT-96000 Recorders can operate as normal printers.

 **Enter Line
Printer Mode**

To enter Line Printer Mode and specify the format, enter the following command:

Command: [LP] [n] [*]

Parameters: n = 1 for an 80-column line printer

n = 2 for a 160-column line printer

n = 3 for a page printer (book format)

n = 4 for an 80-column line printer (180 degrees)

n = 5 for a 160-column line printer (180 degrees)

Example: LP 1 <cr><lf>

causes the recorder to function as a standard 80-column line printer.

Figure 3-1 illustrates the 80-column line printer; Figure 3-2 illustrates the 80-column line printer in 180-degree rotation.

Note: The 160-column printer will have a gap between the first 80 and second 80 characters due to printhead limitations. The help sheets are an example of the 160-column printer mode.

All data characters transferred are processed normally by the recorder. Control characters that may normally be used for command termination are interpreted as follows:

Horizontal tab (09H) tabs in 8-space increments.

Line feed (0AH) advances the pointer to a new line.

Form feed (0CH) advances the pointer to a new page.

Carriage return (0DH) advances the pointer to the beginning of a new line.

Control C (03H) exits Line Printer Mode to Idle Mode.

In the printer modes, the MT-95000 and MT-96000 Recorders accept an unlimited number of characters into a buffer until receiving a <lf> (line feed) or <ff> (form feed). Upon a <lf> or

<ff> the printer prints the buffer contents immediately, up to 80 characters. Upon receiving a <cr> (carriage return), the recorder returns to the beginning of the same line and begins over-writing the buffer. The only difference between line mode and page mode is the buffering of data. In line mode the buffering is done on a line basis; in page mode it is done on a page basis.

The only method for exiting printer operation to return to Idle Mode is sending 03H (ASCII Control-C).

Rotated Printer Mode

The Rotated Printer Mode allows the MT-95000 and MT-96000 Recorders to print comments in the same direction as the eight waveform channels, that is, in 90-degree rotation. This mode is useful for annotation prior to or after an analog record. A maximum of 120 rows of ASCII printing characters can be placed before and/or after waveform output. Figure 3-3 provides a sample of rotated printing.

The recorder accepts 132 characters per row. The total buffering capability per printing sequence is 15,840 bytes (132 x 120). Printing is done on command.



Enter Rotated Printer Mode

The following command enters the MT-95000/MT-96000 into Rotated Printer Mode:

Command: [RP] [*]
Parameters: none

After entering this mode, the recorder accepts control characters and ASCII character data.

ASCII Character Data

Valid ASCII data is 20-7FH, upper and lower case characters. This data is accepted row by row and placed in a buffer, to be printed only upon receiving a print command (0CH). You can send up to 132 characters per row and up to 120 rows. The recorder will print the first 60 rows on the left side of the paper and the last 60 rows on the right side. The width of the output is controlled by the width of the widest character row.

131

132

Figure 3-3: Rotated Printer Mode

If you wish to use this feature to annotate other recorder output, you must format the information in a manner that allows it to correlate with the appropriate output.

Control Characters

- 0DH — Carriage return sets the cursor back to the first column.
- 0AH — Line feed advances the cursor to the next row of the same column.
- 0CH — This command stops filling the buffer and prints the entire contents of the buffer.
- 03H — This command causes the recorder to exit Rotated Printer Mode and to return to Idle Mode.
- 09H — This command inserts one blank column of white space before or after any buffer printing. This command is not placed in a buffer; it is executed upon receipt.

Plotter Mode

The MT-95000 and MT-96000 Recorders' high-resolution printing capability enables use of the recorders for custom printing applications. Some applications may include histograms, custom characters or logos, and even custom recorder formats.

The host can control all printing elements (pixels) on an individual basis. This section details the exact format the host must send the bit-map-addressable data and how that correlates with the recorder's printhead.

Plotter Mode Specifications:

Resolution (printhead):	300 dots per inch
Resolution (time):	400 dots per inch
Raster line input rate:	400 lines per second
Element control:	1 = on, 0 = off
Maximum image width:	190 millimeters
Maximum image length:	host-controlled



Enter
Plotter Mode

The command that enters the MT-95000/MT-96000 into Plotter Mode is as follows:

Command: [HR] [*]
Parameters: none
Example: HR <cr><lf>

After entering into Plotter Mode, the recorder reacts immediately to two different types of information:

- Data Packets, which are true bit-map-addressable data and will print as soon as received
- Control Packets, which include information that changes how the recorder prints in Plotter Mode or exits the Plotter Mode

Data packets start with a header code of "D". Control packets start with a header code of "C".

Data Packets

Data packets containing large amounts of binary information are fed to the MT-95000/MT-96000 for printing. One packet contains all the information required to print one line, up to 190 millimeters wide. Data packets contain an ASCII "D" header to differentiate them from control information.

The components of a Plotter Mode data packet for GPIB communication are: D [count, address, string] [end of packet]

D	=	ASCII D (44H) sequence header
<space>	=	header separator
Count	=	two-byte count of number of data bytes in string field. Count should be in low-byte/high-byte format. Valid (1 to 280).
Address	=	two-byte address, which is the physical location of the string in the print map (0 to 279). Address should be in low-byte/high-byte format.
String	=	binary data bytes 00H to FFH representing data to be printed.
End of packet	=	FFFFH should be the last two bytes of the packet.

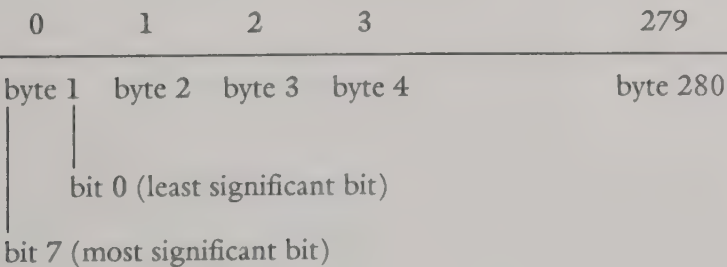
Note: The MT-95000/MT-96000 must be set up for EOI only termination when in an GPIB configuration in order to use the binary transfer that is required of the mode.

The components of a Plotter Mode data packet for RS-232 communication are: D [count, address, string] [end of packet]

- D = ASCII D (44H) sequence header
- <space> = header separator
- Count = four-digit count of number of data bytes in string field. Count should be in ASCII notation. Valid (0001 to 0280).
- Address = four-byte address, which is the physical location of the string in the print map (0000 to 0279). Address should be transferred in ASCII format.
- String = ASCII codes '0' - '9' and 'A' - 'F'. Each pair of codes will be decomposed into a binary data byte which fits the print map. This string shall have two times the number of bytes specified in the count, due to ASCII format of transfer.
- End of packet = 'FFFF' should be the last four codes of the packet.

Note: You must also add a linefeed <lf> terminator to the data packet with RS-232 communication.

The recorder places the plotter data into a specific bit-map area that is oriented in accordance with the thermal printhead. Two hundred and eighty bytes equals approximately 190 millimeters, the maximum image width.



Control Packets

Control packets are used to send commands to the MT-95000/MT-96000 in Plotter Mode. Command headers begin with a control header code of "C."

Table 3-19: Plotter Mode Commands

<i>Header</i>	<i>Function</i>
C RS	Determine print resolution.
C EX	Exit Plotter Mode and return to Idle Mode.

Change Print Resolution

The *Change Print Resolution Command* specifies whether raster lines are to be printed at a resolution of 16 or 8 or 4 lines per millimeter. The default resolution for Plotter Mode is 16 lines per millimeter in the direction of paper feed.

Command: [C] [RS] [x] [*]

Parameters: x = 0 for 16 lines per millimeter
x = 1 for 8 lines per millimeter
x = 2 for 4 lines per millimeter

Example: C RS 1 <cr><lf>
changes the resolution from the default of 16 lines per millimeter to 8 lines per millimeter.

Exit Plotter Mode

The *Exit Plotter Mode Command* causes the MT-95000/MT-96000 to exit the Plotter Mode and return to Idle Mode.

Command: [C] [EX] [*]

Parameters: none

Appendix A: Command Headers

Mode Entry Command Headers

SY	Enter System Setup Mode
RT	Enter Analog Real-time Recorder Mode
DL	Enter Data Logger Mode
AC	Enter Acquire Mode (Data Capture)
PB	Enter Data Playback Mode
DS	Enter Digital Data Recorder Mode
XF	Enter Data Transfer Mode
LP	Enter Line Printer Mode
RP	Enter Rotated Printer Mode
HR	Enter Plotter Mode
FF	Perform a Form Feed
HS	Print a Help Sheet

Function Command Headers

System Setup

General System:

TI	Set time
DA	Set date
MC	Define source of motor clock
ME	Memorize (store) setup
RE	Recall (retrieve) setup
GT	Select source of gain setting
CO	Determine channel order
TT	Set timer marker interval
SG	Synchronize vertical grid (MT-96000 only)
RM	Control right system event marker
LM	Control left system event marker (MT-96000 only)
MB	Define service request mask byte (GPIB only)
DF	Set system defaults
ER	Report on MT-95000/MT-96000 status

Channel Setup:

CP	Change coupling (DC or ground) for a channel
VO	Set full-scale volt range
ZE	Position zero volts (ground) on chart
PO	Change signal polarity (normal or inverted)
CA	Calibrate all analog channels
AE	Annotate channel with alphanumerics or event marker
CR	Enable or disable reporting on signal conditioner for a channel
PL	Lift pen (disable printing) for an analog channel
NC	Define numeric calibration of each channel

Grid Setup:

PR	Turn major grids on or off
MN	Turn minor grids on or off
AI	Enable or disable printing of signal identifier

Data Capture (Acquire) Setup:

SR	Set sample rate for data capture
SV	Define storage method and window size for data capture

Trigger Setup:

TS	Define trigger source
TL	Define trigger level and slope
TP	Define trigger position

Playback Setup:

XY	Select x and y channels
MG	Specify reduction or magnification of playback
PP	Specify percentage of playback

Exit System Setup Mode:

EX	Exit System Setup Mode
----	------------------------

Analog Real-time Recorder

ST	Start or stop the recorder output (toggle)
RU	Start recorder output
HA	Halt recorder output
SP	Change and set speed
ID	Label the waveforms with numeric identification
SC	Turn system log channel print control on or off
ES	Edit system log channel buffer
PB	Control printing of interchannel text buffer
ED	Edit interchannel buffers
TT	Set timer marker interval
SE	Turn the system event marker(s) on or off
RM	Control right system event marker
LM	Control left system event marker (MT-96000 only)
AC	Arm/disarm background data capture
ER	Report on MT-95000/MT-96000 status
EX	Exit Analog Real-time Recorder Mode to Idle Mode

Channel Setup:

CP	Change coupling (DC or ground) for a channel
ZE	Position zero volts (ground) on chart
PL	Lift pen (disable printing) for an analog channel
PO	Change signal polarity (normal or inverted)
VO	Set full-scale volt range
CA	Calibrate all analog channels
CR	Enable or disable reporting on signal conditioner for a channel

Acquire Setup:

SR Set sample rate for data capture
SV Define storage method and window size for data capture

Trigger Setup:

TS Define trigger source
TL Define trigger level and slope
TP Define trigger position

Data Logger

ST Start or stop the recorder output (toggle)
RU Start recorder output
HA Halt recorder output
SP Change and set logging speed
AC Arm/disarm background data capture
ER Report on MT-95000/MT-96000 status
EX Exit Data Logger Mode to Idle Mode

Channel Setup:

CP Change coupling (DC or ground) for a channel
ZE Position zero volts (ground) on chart
PL Lift pen (disable printing) for an analog channel
PO Change signal polarity (normal or inverted)
VO Set full-scale volt range
CR Enable or disable reporting on signal conditioner for a channel

Acquire Setup:

SR Set sample rate for data capture
SV Define storage method and window size for data capture

Trigger Setup:

TS Define trigger source
TL Define trigger level and slope
TP Define trigger position

Data Capture (Acquire)

ER	Request error or completion status
EX	Exit (abort) acquisition and return to Idle Mode

Data Playback

ST	Start or stop the recorder output (toggle)
RU	Start recorder output
HA	Halt recorder output
ID	Label the signals with numeric identification
PB	Control printing of interchannel text buffer
ED	Edit interchannel buffers
ER	Request error or completion status
EX	Exit Data Playback Mode to Idle Mode

Digital Data Recorder Mode

C ID	Label the waveforms with numeric identification
C SC	Turn system log channel print control on or off
C ES	Edit system log channel buffer
C PB	Control printing of interchannel text buffer
C ED	Edit interchannel buffers
C SE	Turn the system event marker(s) on or off
C PL	Lift pen (disable printing) for an analog channel
C PO	Change signal polarity (normal or inverted)
C MS	Control motor step
C EX	Exit Digital Data Recorder Mode to Idle Mode

Data Transfer Mode

RI	Request information about acquisition (data capture memory).
WV	Select waveform(s) and initiate transfer.
EX	Exit Data Transfer Mode and return to Idle Mode.

Plotter Mode

C RS	Determine print resolution.
C EX	Exit Plotter Mode and return to Idle Mode.

Appendix B: Event Marker Options

Right System Event Marker Options

<i>Right Marker</i>	<i>Time Source</i>	<i>Timer</i>	<i>DIP Switch 4</i>	<i>Function</i>
Off		--	--	off
External		--	--	system event 2
Timer	internal	off	--	flat line
Timer	internal	.1	--	pulse each .1 second
Timer	internal	1	--	pulse each 1 second
Timer	internal	10	--	pulse each 10 seconds
Timer	internal	60	--	pulse each 60 seconds
Timer	IRIG/ NASA			code start pulse
Tri-level		--	on	.01/.1/1 seconds
Tri-level	internal	.1	off	.1/1/10 seconds
Tri-level	internal	1	off	1/10/100 seconds
Tri-level	internal	10	off	10/100/1000 seconds
Tri-level	internal	60	off	1/10/100 minutes
Tri-level	IRIG A	--	off	.1/1/10 seconds
Tri-level	IRIG B	--	off	1/10/100 seconds
Tri-level	NASA 36	--	off	1/10/100 seconds
Tri-level	IRIG H	--	off	1/10/100 minutes

Note: Tri-level options are available only for the MT-96000 Recorder.

Left System Event Marker Options

<i>Left Marker</i>	<i>Time Source</i>	<i>Timer</i>	<i>DIP Switch 4</i>	<i>Function</i>
Off		--	--	off
External		--	--	system event 1
Tri-level		--	on	.01/.1/1 seconds
Tri-level	internal	.1	off	.1/1/10 seconds
Tri-level	internal	1	off	1/10/100 seconds
Tri-level	internal	10	off	10/100/1000 seconds
Tri-level	internal	60	off	1/10/100 minutes
Tri-level	IRIG A	--	off	.1/1/10 seconds
Tri-level	IRIG B	--	off	1/10/100 seconds
Tri-level	NASA 36	--	off	1/10/100 seconds
Tri-level	IRIG H	--	off	1/10/100 minutes

Note: Tri-level options are available only for the MT-96000 Recorder.

Appendix C: Multiline Interface Messages

16-BIT INTERFACE MESSAGE STRUCTURE

The message is structured as follows:

- Addressed Command Group (ACG):** 4 bits (bits 1-4)
- Universal Command Group (UCG):** 4 bits (bits 5-8)
- Listen Address Group (LAG):** 4 bits (bits 9-12)
- Talk Address Group (TAG):** 4 bits (bits 13-16)

Secondary Command Groups (SCG): These are defined by the LAG and TAG fields. They include:

- UNL (Universal Command Group):** 4 bits (bits 9-12)
- LAG (Listen Address Group):** 4 bits (bits 13-16)
- TAG (Talk Address Group):** 4 bits (bits 17-20)
- SCG (Secondary Command Group):** 4 bits (bits 21-24)

Command Codes and Meanings:

Code	Meaning
0000	NUL
0001	SOH
0010	STX
0011	ETX
0100	EOT
0101	ENQ
0110	ACK
0111	BEL
1000	BS
1001	HT
1010	LF
1011	VT
1100	FF
1101	CR
1110	SO
1111	SI

Notes:

- MSG = INTERFACE MESSAGE
- $b_1 = \text{DIO1} \dots b_7 = \text{DIO7}$
- REQUIRES SECONDARY COMMAND
- DENSE SUBSET (COLUMN 2 THROUGH 5)

Index

A

Abort Command 2-6
Acquire Commands 3-37
Acquire Setup Commands 3-19
acquired data 3-19, 3-20, 3-31, 3-35, 3-37, 3-38, 3-49
acquisition 3-19, 3-20, 3-31, 3-35, 3-37, 3-38, 3-49
acquisition settings 3-37
active system setup 3-4, 3-8
alphanumeric annotation 3-16
Analog Channel Calibration Command 3-16
Analog Real-Time Recorder Commands 3-25, 3-26
Analog Real-time Recorder Mode 3-24
analog real-time recording 3-24
analog trigger 3-20
annotation, interchannel 3-16, 3-27, 3-40, 3-47
annotation, printer 3-53
ASCII character data 2-3, 3-43, 3-49, 3-53, 3-58
ASCII header 3-40, 3-43, 3-46, 3-53, 3-54, 3-58, 3-60
Automatic Identification Command 3-18

B

Background Data Capture Command 3-31, 3-40
baseline offset 3-16
baud rate 2-4
binary data 3-42, 3-49
bitmapped graphic printing 3-57
buffer, print 3-52, 3-53, 3-57
buffers, interchannel 3-16, 3-27, 3-40, 3-47

C

- C950 card cage 3-8
- calibration 3-16, 3-17
- captured data 3-19, 3-31, 3-35, 3-37, 3-38
- Change Print Resolution Command 3-60
- Channel Order Command 3-9
- Channel Setup Commands 3-14
- chart divisions 3-18
- chart formats 3-24, 3-38, 3-42
- chart speeds 3-27, 3-35
- command format 3-1, 3-45, 3-60
- command header 3-1, 3-45, 3-60
- command structure 3-2
- communications interface 2-1, 2-6, 3-13, 3-42, 3-51, 3-58
- communications menu 2-4, 2-7
- completion status 3-31, 3-36, 3-41
- control characters 3-45, 3-57, 3-60
- control header 3-45, 3-60
- control packets 3-43, 3-45, 3-58, 3-60
- CPU Board end plate 2-1, 2-2
- current system setup 3-4, 3-8
- custom printing 3-57

D

- data analysis 3-49
- data acquisition 3-19, 3-21, 3-31, 3-35, 3-37, 3-38, 3-49
- data capture 3-19, 3-21, 3-31, 3-35, 3-37, 3-38, 3-49
- Data Capture Commands 3-37
- data capture memory 3-20, 3-49
- Data Capture Mode 3-37
- data capture sample rates 3-19, 3-37, 3-49
- Data Logger Commands 3-33, 3-34
- Data Logger Mode 3-33
- data packets 3-43, 3-50, 3-58
- data playback 3-22, 3-38
- Data Playback Commands 3-39
- Data Playback Mode 3-38
- data transfer 3-42, 3-49
- Data Transfer Commands 3-49
- date and time 3-3, 3-7

DC signal 3-15
DC-950 Data Capture option 3-19, 3-22, 3-31, 3-35, 3-37, 3-38
Default Command 3-4
default setup 3-4, 3-5, 3-13
Define Service Request Command 3-13
DI-488-950 Digital Interface option 3-42
digital data 3-33, 3-37, 3-38, 3-42, 3-49, 3-58
Digital Data Recorder Commands 3-46
Digital Data Recorder Mode 3-42
DTR/DSR handshaking 2-3

E

Edit Interchannel Text Buffer Command 3-28, 3-40, 3-47
Edit System Log Channel Command 3-27, 3-46
enable remote (host) control 2-5
EOI (end or identify) 2-8, 3-43, 3-44, 3-45, 3-51, 3-59
Error/Status Command 3-13, 3-32, 3-36, 3-38, 3-39, 3-41
errors 2-10, 3-13, 3-36
event markers 3-10, 3-16, 3-28, 3-29
Exit Analog Real-time Recorder Mode Command 3-32
Exit Command 3-23, 3-32, 3-36, 3-37, 3-41, 3-48, 3-51, 3-60
Exit Data Logger Mode Command 3-36
Exit Data Playback Mode Command 3-41
Exit Data Transfer Mode Command 3-51
Exit Digital Data Recorder Mode Command 3-48
Exit Plotter Mode Command 3-60
exit remote (host) control 2-5
Exit Setup Mode Command 3-23
expanded data 3-31, 3-35
external clock 3-7, 3-9, 3-10, 3-12, 3-29, 3-30
external signal conditioner 3-8, 3-15

F

Form Feed Command 3-3
formats, chart 3-24, 3-38, 3-42
formats, line printer 3-52
frequency response 3-19
full data packets 3-43
full-scale voltage 3-15
function commands 3-2

G

gain control 3-8, 3-15
gain self-calibration 3-16
gain source 3-8, 3-15
Gain Source Command 3-8
General System Commands 3-6, 3-7
GPIB address 2-7
GPIB capabilities 2-9
GPIB communications 2-6, 3-13, 3-42, 3-51, 3-58
GPIB interface commands 2-9
Grid Setup Commands 3-18
grids 3-9, 3-18
ground 3-15

H

handshake protocol 2-3
hardwired 2-4, 2-5
Halt Command 3-26, 3-35, 3-40
Help Sheet Command 3-3

I

Identification (ID) Command 3-27, 3-40, 3-46
Idle Mode 2-6, 3-2, 3-23, 3-32, 3-36, 3-37, 3-41, 3-48, 3-51, 3-60
IEEE-488 connector 2-6
initial setup 3-3
input frequency 3-19
input signal 3-15, 3-27, 3-40, 3-46
Interchannel Annotation/Event Marker Command 3-16
interchannel buffer 3-16, 3-27, 3-40, 3-47
Interchannel Text Buffer Command 3-27, 3-40, 3-47
internal clock 3-7, 3-10, 3-12, 3-29, 3-30

L

Left System Event Marker Command 3-12, 3-30
line mode 3-53
line printer 3-52
Line Printer Modes 3-52
local control 2-5, 2-8
logging speed 3-35

M

Magnification Command 3-22
magnification of data 3-22
major chart grid 3-18
Memorize or Recall Setup Commands 3-4, 3-8
memory 3-20, 3-49
Minor Divisions Command 3-18
minor grid divisions 3-18
mode commands 3-2
modes of operation 1-3, 3-2, 3-4, 3-24
Motor Clock Source Command 3-7
motor speed 3-27, 3-35
Motor Step Command 3-48
MT-95000/MT-96000 Operations Manual 1-1
MT-95000/MT-96000 Maintenance and Service Manual 1-1
MT-96000 Recorder 3-9, 3-11, 3-12, 3-18, 3-29, 3-30

N

non-volatile memory 2-5, 2-7
Numeric Calibration Command 3-17, 3-33
numeric data 3-17, 3-33, 3-37, 3-42
numeric format 3-33, 3-37
numeric identification 3-27, 3-40, 3-46

O

overlapped recording 3-18, 3-27, 3-40, 3-46

P

page mode 3-53
Pen Lift Command 3-17, 3-48
pin connection 2-1, 2-6
pixels 3-57
playback 3-22, 3-38
Playback Command 3-39
Playback Percentage Command 3-23
Playback Setup Commands 3-22
Plotter Mode 3-57
Plotter Mode Commands 3-60
polarity 3-16, 3-48
Print Control Command 3-18
print rate 3-27, 3-35
printhead 3-52, 3-57, 3-59
printing, annotation 3-53
printing, bitmapped graphics 3-57
printing, line printer 3-52
Printing Modes 3-52
printing, rotated 3-53
protocol, communications 2-4

R

raster lines 3-57, 3-60
Real-time Recording Modes 3-24
rear panel, MT-95000/MT-96000 2-1, 2-2
Recall Setup Command 3-4, 3-8
reduction of data 3-22
Request Information Command 3-50
resolution 3-57, 3-60
Right System Event Marker Command 3-10, 3-29
Rotated Printer Mode 3-53
RS-232 communications 2-1, 3-51, 3-59
Run and Halt Commands 3-26, 3-35, 3-40

S

sample points 3-49
sample rates 3-19, 3-37, 3-49
Sample Rate Command 3-19
serial poll 2-10, 3-13
service request 2-10, 3-13
Set Date Command 3-7
Set Time Command 3-7
Set/Change Logging Speed Command 3-35
Set/Change Motor Speed Command 3-27
Signal Conditioner Reporting Command 3-17
Signal Coupling Command 3-15
signal identification 3-18, 3-27, 3-40, 3-46
Signal Polarity Command 3-16, 3-48
single data packet 3-44
speed, motor 3-27, 3-35
Start/Stop Toggle Command 3-26, 3-33, 3-39
status byte 2-10, 3-13
status information 3-13
storage method 3-20, 3-37, 3-50
Storage Method Command 3-20
stored data 3-19, 3-20, 3-31, 3-37, 3-38, 3-49
stored system setup 3-4, 3-8
Synchronize Grid Command 3-9
System Default Command 3-13
System Default Setup 3-4, 3-5, 3-13
System Event Marker Command 3-28, 3-47
system log channel 3-27, 3-46
System Log Channel Command 3-27, 3-46
system settings 3-3
System Setup Commands 3-6
System Setup Mode 3-3

T

terminator 2-5, 2-8, 3-1, 3-43, 3-50, 3-59
text buffers 3-16, 3-27, 3-40, 3-47
time and date 3-3, 3-7
Timer Mark Interval Command 3-9, 3-28
timing marks 3-9, 3-10, 3-12, 3-28, 3-29, 3-30
trigger 3-20, 3-37

trigger channels, active 3-20
Trigger Level/Slope Command 3-21
Trigger Position Command 3-21
Trigger Setup Commands 3-20
Trigger Source Command 3-20
troubleshooting 2-10, 3-13, 3-32, 3-36

U

upload 3-49

V

voltage, full-scale 3-15
voltage range 3-15
Voltage Range Command 3-15

W

Waveform Transfer Command 3-50
window size 3-20, 3-37, 3-50

X

X and Y Channels Command 3-22
Xon/Xoff handshaking 2-3, 2-4
x/y plots 3-22

Z

zero and gain control 3-8
Zero Position Command 3-15

www.manualsplus.com



1016628